POWER PLANT ENGINEERING

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Power for Candy Making

THE PLANT OF THE ROBT. A. JOHNSTON CO., MILWAUKEE, CONTAINS NOTEWORTHY INSTALLATIONS OF POWER GENERATING, REFRIGERATING, AND AIR CONDITIONING EQUIPMENT

IT WOULD SEEM that we Americans have a particularly sweet tooth. We like candy, good candy, and apparently lots of it. Especially does this seem to be the case since we have added an eighteenth amendment to our constitution. The Robt. A. Johnston Co., who makes candy and cookies, has felt the force of this increased demand and in order to be able to meet it has recently constructed a new plant in Milwaukee. The plant is eight stories high and is, except for the offices, on a portion of the second floor, entirely used for the manufacture of this product. The power plant and a garage constitute a separate building. Another building houses a cafeteria for the use of the employes.

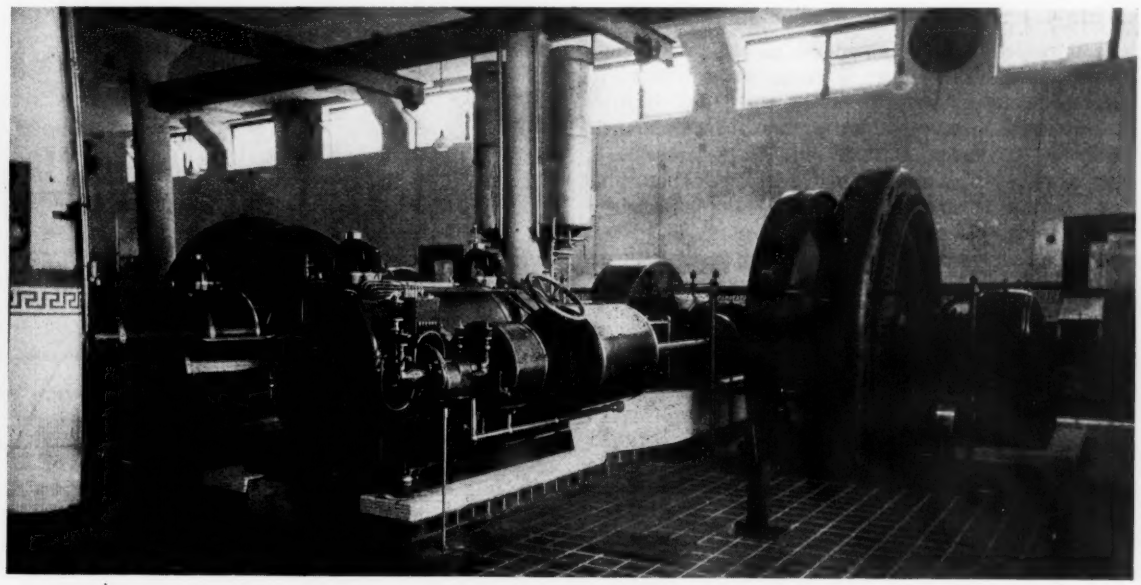


FIG. 1. ENGINE-ALTERNATOR SET AT THE JOHNSTON PLANT

The power plant is of interest in that it is particularly complete, having generating units, remote electrical control, a refrigerating system, air conditioning apparatus and a heating and cooking system.

BOILER ROOM EQUIPMENT

STEAM IS generated for this plant at 140 lb. pressure and at a superheat of 75 deg. F. in four 200 hp. Wickes horizontal return tubular boilers, shown in Fig. 2, set in pairs each 78 in. in diameter by 20 ft. long and having eighty-six 4-in. tubes. The total heating surface of each boiler is then 2000 sq. ft. which at a builder's rating of 10 sq. ft. per boiler hp. gives a rating of 200 hp. The steam is taken off through a dry pipe in a 5-in. line to a superheater. Another 5-in. nozzle is fitted with twin pop safety valves set at 140 lb. pressure. The 2½-in. blowoff line from the rear of the shell is protected from the direct action of the furnace gases by a fire brick pier.

A Dravo superheater is located in the space between the rear tube sheet and the back furnace wall and occupies about one-third of this space. It is at such a height that the top tier of tubes is about on a level with the center line of the boiler shell. The tubes, which extend crosswise of the setting, are 108 in. long, 79 in. of this length is in the combustion chamber, the rest is in the side wall connecting to a header or riser on the outside. This bank, two tubes deep and seven high, is capable of superheating 6900 lb. of steam per hr. 75 deg. F. A pop safety valve on this header is set for 138 lb. a

slightly lower pressure than that for the pair on the shell. In the outside line between the boiler and the superheater is a steam separator whose function it is to prevent entrained water and foreign material from getting into the superheater tubes to cause excessive deterioration there.

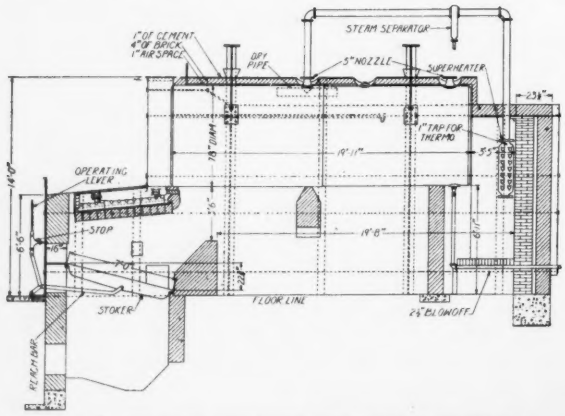


FIG. 2. SECTION THROUGH THE BOILER SETTING

The furnace is built with a Dutch oven extension to provide ample space in which combustion may be completed before the gases come in contact with the boiler shell. The volume over the grate and under the flat bridge wall is approximately 85 cu. ft. The rest of the combustion space, consisting as it does of all the space under the shell, amounts to about 900 cu. ft. A baffle wall suspended from about the middle of the shell to within 3½ ft. of the floor level serves to deflect the furnace gases down, away from the shell, and insures a more intimate mixture of the combustible gases with the air.

The setting is designed for hand-fired operation. The Cokal grate is of the shaking and dumping variety

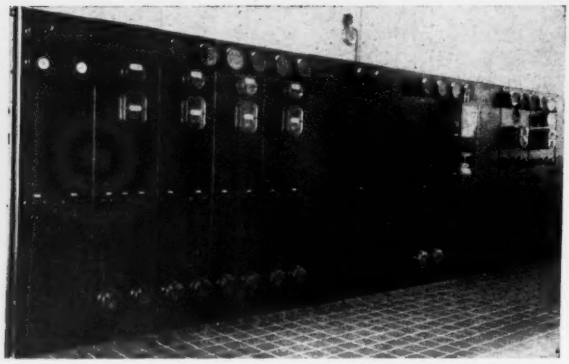


FIG. 3. FRONT VIEW OF THE CONTROL BOARD. THE ABSENCE OF ALL HEAVY CURRENT APPARATUS IS NOTEWORTHY

and is inclined downward toward the rear. It is 7 ft. deep and 6½ ft. wide and has an area of approximately 45 sq. ft. The ratio of heating to grate surfaces is then about 45 to 1. Ash is received in a pit under the grate from which it is raked out into an ash conveyor in a tunnel beneath the firing aisle which lifts it to a spout that discharges into a truck.

Draft is supplied from this battery of boilers by a brick stack, 175 ft. high, above the grates, and 7 ft. diameter at the top. This stack has a capacity sufficient to handle four additional boilers which are to be installed adjacent to the present battery in the future. The breeching has an area, at the entrance of the stack, of about 42 sq. ft. as compared to the 38.5 sq. ft. chimney area at the top.

Under the present load conditions this plant consumes about 20 t. of Illinois screenings or mine-run coal per working day. The coal is unloaded from cars, on a siding adjacent to the plant, into piles longside the track. From here it is conveyed to the boiler room floor directly in front of the boilers where the firemen can get at it.

Due primarily to the extension furnace settings, this plant is able to operate smokelessly. Never is there more than the faintest haze at the top of the stack.

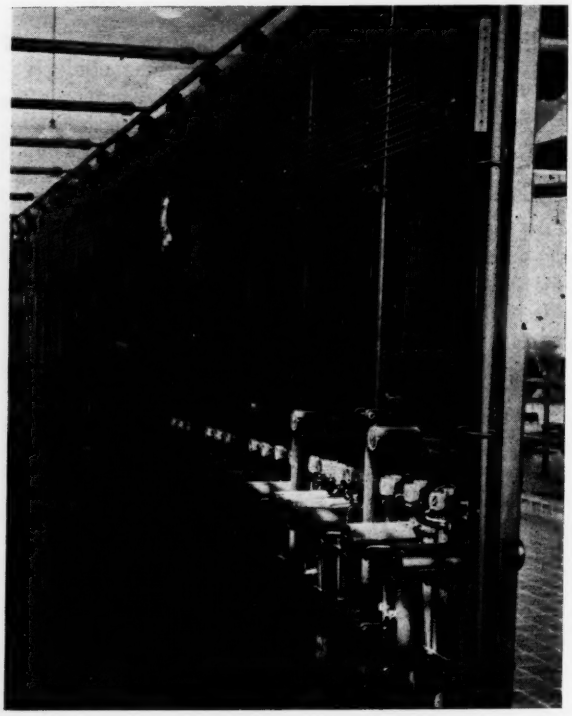


FIG. 4. REAR VIEW OF THE CONTROL BOARD SHOWING THE LIGHT CONTROL CIRCUITS

Steam generated in these boilers is taken off in a 4-in. line to an 8-in. header from which there is a 6-in. line to each of the two engines and a 4½-in. line to the boiling kettles in the factory.

Electric Generators

THE GENERATOR room is on the street level and also about on a level with the tops of the boilers; it is beautifully finished in white tile and is most artistically decorated. There is not the slightest suggestion of grease or dirt or disorder anywhere about the place. The power plant in this factory is not one of the side-tracked, stuck-off-in-a-corner departments that it is in some factories. On the contrary it is one of the show places. The generator room is one that might well be nicknamed the ball-room. Except in one corner of the room where there are a few refrigerating pipe lines, there is not a pipe to be seen, nor are there any heavy conduits in view.

The generators occupy the west end of the room, the refrigerating system exchangers and strong liquor pump are in the northeast corner, and the switchboard and a motor-generator set are along the south wall. The east-center section of the floor is cut away to provide light for the basement where are located the ammonia generator, the water cooling apparatus, all high tension electric lines, the switch room, and all steam, exhaust, water, ammonia and brine piping.

Current is supplied to the factory for power purposes at 220 v. 60 cycle, 3 phase by two 500-kv.a. Crocker-Wheeler rotor field alternators direct connected to two 18 by 24 in. 500-hp. Nordberg horizontal, poppet valve, uniflow engines as shown in Fig. 1. Both these figures are for maximum rating at 200 r.p.m.; the 500 kv.a. is the allowable output corresponding to a 50 deg. C. rise in temperature of the generator. The normal rating is 400 kv.a. with a 40 deg. C. rise. On account of the fact that the piping is in the basement, both steam and exhaust ports are on the underside of the cylinder. A receiver of large capacity is located immediately in front of this valve to iron out somewhat the pulsations in the steam line. The cylinder is steam jacketed and insulated around the walls and heads. Both steam and exhaust valves are operated by a cam actuated by an eccentric rod driven by an eccentric on a lay shaft. A shaft inertia governor which controls the position of the eccentrics and a Falls automatic stop governor which actuates a butterfly valve in the steam line when the speed of the engine reaches a certain predetermined value are also on this shaft.

Under the conditions now obtaining in the plant these engines take steam at about 140 lb. gage pressure and 65 deg. F. superheat and exhaust at about 2 lb. back pressure to either or both the heating and refrigerating systems.

On account of the temperature gradient experienced in the cylinders of engines of this type, they are made so as to be slightly barrel shaped when cold, i. e., the diameter at the center where exhaust occurs and where the temperature reaches its lowest value, is greater than that at the ends. When the cylinder attains its normal running temperature, the bore becomes the same throughout its length. This construction is necessary to prevent seizing at the center or a loose fitting piston at the ends.

Wear on the piston and cylinder is reduced to a minimum by a tail rod which runs on a guide on an extension at the head of the cylinder.

Power developed by this engine is absorbed by a rotor field alternator rated at 500 kw. It will be seen that thus the capacity of the generator is about 34 per cent greater than that of the engine. This design is to prevent any serious overload on the system from burning out the generator. Excitation for the field is supplied by an exciter mounted on a pedestal cast on the outboard bearing and driven from the main crankshaft by a silent chain running in oil.

Because of the fact that most of the load is due to induction motors, the power factor in this plant averages around 70 per cent. To obtain this factor, which would otherwise be lower, and to provide direct current for variable speed motors for elevator service, a 200-kw. synchronous motor driving a 100-kw. d.c. generator has been installed in the generator room. Here the extra capacity of the synchronous motor is used for power factor correction.

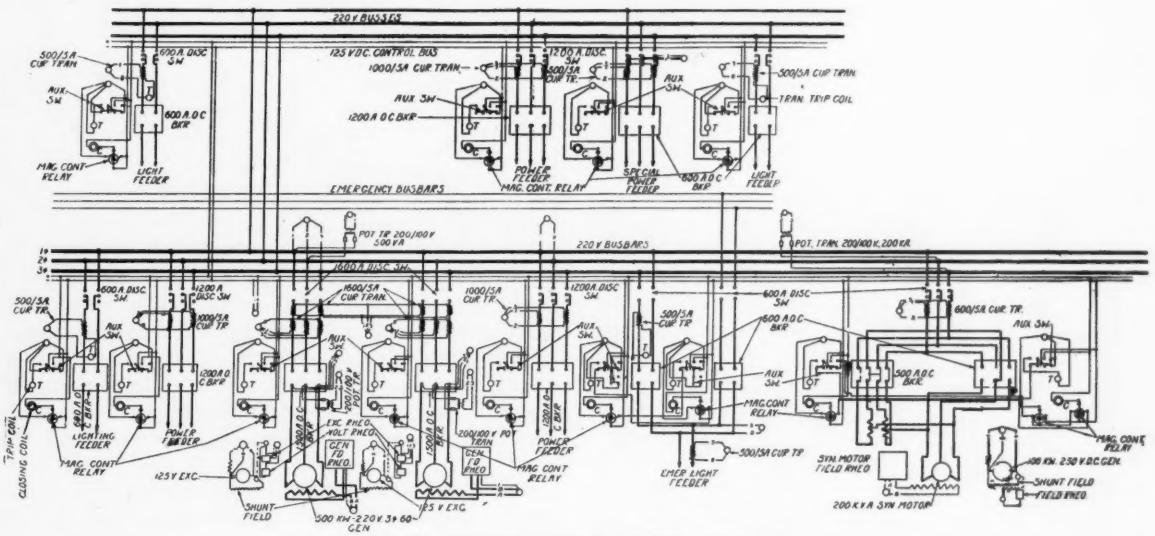


FIG. 5. REMOTE CONTROL WIRING DIAGRAM

Of particular interest is the Westinghouse remote control system in use in this plant. All knife and cutout switches, busses and rheostats are in the basement in a special isolated switch structure room which is screened in with copper screening. This equipment is of such size that it is capable of safely handling a future growth of 1000 kw. Control is effected from the 15 panel switchboard in the engine room where only a light control circuit is used. Figures 3 and 4 shows the front and rear views of this board, the total absence of power switches and busses is noteworthy.

This panel contains the usual ammeters, voltmeters, voltage recorder, voltage regulator, kilowatt meters, kilowatt hour recorders, overload relays, power factor meter, frequency meter and synchronoscope. A system of push buttons operate solenoid switches in the switch room. Figure 5 shows the wiring diagram of this instal-

lation. Signal lights in red, green and white indicate what connections are made and whether the power circuits are opened or closed.

A public service bus in the switch room is available at all times, supplying current through a tie switch to the plant bus in case of an emergency. At present this line is used at night to take care of the lighting load.

Refrigerating System

Certain of the processes employed in the manufacture of candy require considerable amounts of refrigeration capacity. These needs are supplied in this plant by a 150-ton Carbondale absorption refrigerating machine. The generator of this system is in the basement of the engine room in the southeast corner; the aqua receivers, exchangers and pump shown in Fig. 6 are in the engine room as previously mentioned. The generator or strong liquor boiler is 63 in. in diameter by 18 ft. long and is provided with a bank of steam coils. Steam at 2 lb. pressure condensing in these coils gives up its heat to the strong liquor which boils and releases ammonia vapor which passes off to the rectifier. At the same time the resulting hot weak liquor is carried over to the exchanger. In the rectifier, which is located on the roof of the engine room, the ammonia gas is cooled somewhat and any moisture which may have been entrained is condensed out and returned to the generator. The rectified or analyzed gas passes over to the ammonia condenser where it is reduced to the liquid state.

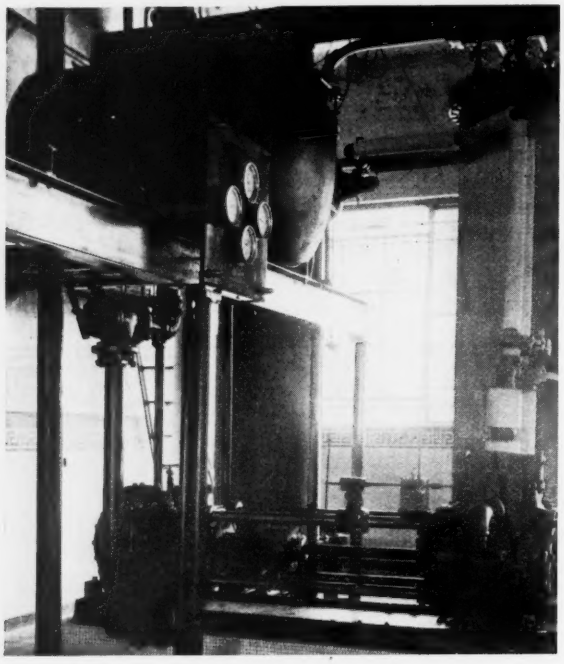


FIG. 6. A PART OF THE REFRIGERATING EQUIPMENT SHOWING THE STRONG LIQUOR PUMP, THE AQUA RECEIVER AND THE EXCHANGERS

The condensed ammonia then drains to an anhydrous receiver in the basement from which it is admitted through an expansion or regulating valve to the expansion coils in both the water and brine coolers. The gas taken from these coils is introduced with cooled weak liquor into the absorber, located under the condenser coils on the roof. The strong liquor obtained drains off into the aqua receiver from which it is delivered by means of a direct acting steam pump, through the exchanger, where it is preheated by the hot weak liquor, back to the generator. The weak liquor on passing through the exchanger gives up a part or most of its heat to the strong liquor, is further cooled in a weak liquor cooler on the roof and is then injected with the ammonia gases into the absorber.

The rectifier, weak liquor cooler, condenser and absorber are all coolers of the single pipe condenser type. They are cooled in the manner common to this system by having cold water fall in cascades over the pipes from an overhead trough.

Brine cooled to the required temperature in the brine cooler is circulated through the candy cooling rooms and parts of the bakery and used where cooling is necessary. The spray water for cooling the air in the air conditioning apparatus is piped to the basement of the engine room and cooled there by direct ammonia expansion. The first system is capable of utilizing 150 tons of refrigeration; the second 50 tons. Thus the capacity of the apparatus supplied exceeds that of the generator by 33 per cent.

Air Conditioning

In the manufacture of candy, it is just as essential that certain conditions of air temperature and humidity be accurately maintained as that refrigeration be used. To supply this demand there is installed in this plant a Carrier air conditioning system.

Through a set of thermostatically controlled louvers air from the exhaust duct from the building and from the outside is admitted to the apparatus and mixed in certain proportions depending on the outside temperature. When the outside temperature is about that desired in the building, air is taken almost exclusively from the outside, under other weather conditions only enough fresh air is used to supply the required amount of oxygen for the employes. The air is passed through a fine spray of water having a temperature of about 45 deg. F. It assumes in passing a temperature only slightly above this 45 deg. and at the same time attains a humidity of practically 100 per cent.

This cold, saturated air passes first through a series of baffles, where any entrained moisture is removed, and then through a bank of steam coils, where the temperature is raised to the desired point, into the building. After heating, the air contains the same number of grains of water per pound that it had at 45 deg. but due to heating and expansion the relative humidity is reduced to the required amount, about 50 per cent. Draft is produced to move the air through the apparatus and throughout the building by various blowers belted to induction motors. Three such units are installed, two for the candy making section of the plant and one for the bakery.

Water for the spray in this system is cooled to the required temperature by direct expansion Bandelot coolers. The water is made to flow from a notched trough over

a bank of tubes in which ammonia is expanded. The cooled water in the sump is pumped through the spray nozzles under high pressure and returned to the cooler.

The whole apparatus is automatically controlled by a system of thermostats to maintain constant conditions. The water temperature required to give a certain humidity at a certain temperature is fixed and is regulated by a thermostat that controls the inlet valve on the water cooling system. Another thermostat functions to admit steam to this water if its temperature should fall or if different conditions are required. If the incoming air is at or below the freezing point a system functions to circulate the sump water directly back through the nozzles. The steam coils are automatically controlled to give the correct room temperature.

There are necessarily a great number of cooking operations required in this plant. For this purpose high pressure steam is used and a large portion of the output of the boiler is consumed in this way. The condensate from the generator in the ammonia system and that from the vacuum heating system having a temperature of about 175 deg. F. is mixed with that from the boiling kettles, or the cooking system, by means of a direct acting outside center packed feed pump, and fed back into the boilers through a tilting trap located above them. Two 500-hp. Cochrane open feed-water heaters are used for heating the makeup.

E. C. Guhr is chief engineer of this plant and we are indebted to him and officials of the company for courtesies extended which made this description possible.

Loss of Heat in Brick Chimneys

An Investigation Into the Effect of Air Infiltration on Heat Loss. By Alfred Cotton*

WHILE developing the characteristics of chimneys, taking into account the drop of temperature of the gases as they ascend, the writer inquired into the cause of this temperature drop with somewhat unexpected results.

The published data on chimney temperatures are rather meager. The chart shows those the writer has considered. The curves are numbered for ease of identification, and correspond with the descriptions given in the table.

Curves 1, 2, 3 and 5, as shown in the accompanying chart, are taken from "Steam Boilers" by Peabody and Miller, curve 1 is that of Messrs. Kilborn and Alexander, Massachusetts Institute of Technology, 1911. Curves 4, 6, 7 and 8 are from an article by J. C. Smallwood in Power of Sept. 16, 1919.

In all cases, the temperature drop is much faster at the beginning than near the end of the passage; at first sight, this was to be expected as being similar to the curves of temperature drop in other heat transfer apparatus, but more careful consideration shows that the shape of the curves is not due to heat transmission. The chimney walls are much thicker at the bottom than at the top; and consequently, the heat loss and temperature drop should be much less at the bottom than at the top. This is borne out by the smaller heat loss in buildings with thicker walls, and by the smaller heat transmission through boiler tubes thickly coated with scale; though it is quite obvious without such comparisons. The curves should therefore be convex upwards instead of concave.

The actual heat lost during the passage of the gases through the chimney as represented by their drop in temperature, can only be ascertained when the weight of gases flowing up the stack is known. This is not given; but it may be deduced approximately in the case of curve 1 where about 50 lb. of coal were being burned per square foot of chimney area per hour. Assuming this to be based on the area at the bottom of the stack, and assuming 20 lb. of gas per pound of coal, the weight of gases dealt with was 254,500 lb. per hr. Curve 1 shows that the gas temperature fell 100 deg. Taking the specific heat of the gases as 0.25, the heat loss per pound of gas was 25 B.t.u., or a total loss of 6,362,500 B.t.u. per hr.

Heat transmission through the chimney walls cannot account for all the heat lost. The surface of the inside of the chimney is 13,350 sq. ft., so that the heat transmitted per square foot of wall surface would have to be $6{,}365{,}000 \div 13{,}350 = 477$ B.t.u. The average temperature of the gases is 404 deg., and the temperature of the atmosphere is assumed as 60 deg. The average temperature difference is 344 deg., so that the heat transfer rate from gas to air would be $477 \div 344 = 1.4$ B.t.u. per sq. ft. per hr. per degree difference of temperature.

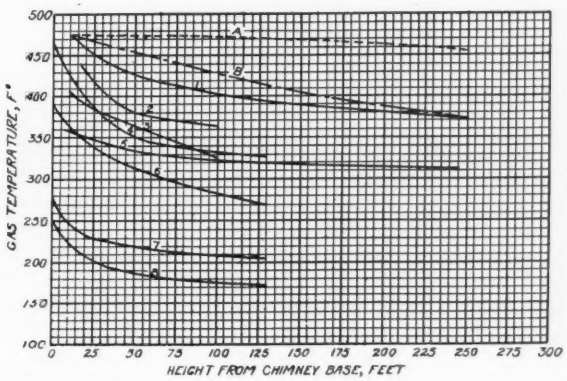


CHART SHOWING FLUE GAS TEMPERATURE AT VARIOUS HEIGHTS IN BRICK CHIMNEYS

The gas rate is 1000 lb. per sq. ft. of gas passage area at the base per hour; and in a boiler, the heat transfer rate would be about 3 B.t.u. per sq. ft. per hour per degree temperature difference. That the heat transfer rate through the thick brick walls of a chimney to the atmosphere should be one-half as great as through thin steel boiler tubes to water, is absurd. Some other explanation must be found.

The figures for heat transmission through brick walls of Wolff and Hauss as given by Kent were used. They are for straight walls, and therefore the mean of the inside and outside surfaces of the chimney walls was taken, and the chimney divided into 20-ft. vertical sec-

* Research engineer, Heine Safety Boiler Co.

tions. By this treatment, the heat transmitted through the walls when using the observed temperatures is 1,074,500 B.t.u., which leaves 5,288,000 B.t.u. unaccounted for.

The only reasonable explanation appears to be infiltration of air and this was then considered. Such air would be heated from the assumed temperature of the atmosphere, 60 deg., to the temperatures of the gases leaving the chimney, 375 deg. The rise in temperature is $375 - 60 = 315$ deg.; using 0.25 as the specific heat, 97 B.t.u. are used in heating each pound of air which leaks through the chimney walls. As there are 5,288,000 B.t.u. per hr. to be accounted for, the amount of air required per hour is $5{,}288{,}000 \div 79 = 67{,}000$ lb. This is $67{,}000 \div 254{,}000 = 26$ per cent of the gases entering the chimney.

The next step is to find out whether such a large amount of leakage is reasonably to be expected. Again taking the mean of the inside and outside surfaces of the chimney walls, which is 14,800 sq. ft., the average leakage per square foot is $67{,}000 \div 14{,}800 = 4.5$ lb. per hr. The average vacuum within the chimney is 0.6 in. of water.

There are no determinations of the porosity of brickwork which are available for the purpose of comparison;

DESCRIPTION OF CHIMNEYS FOR WHICH CURVES ARE PLOTTED IN THE CHART

Curve No.	1,5	4,6,7,8	2	3
Description	Custodis Brick	Custodis Brick	Brick	Steel Unlined
Height, feet	250	130	102	100
Shape of cross section	Round	Hexagonal	Square	Round
Diameter at bottom, inside	18'-0"	8'-9"	3'-0"	3'-0"
Diameter at top, inside	16'-0"	7'-10"	3'-0"	3'-0"
Wall thickness, bottom	36"	27 1/2"	?	-
Wall thickness, top	8"	9"	?	-

but the leakage as already determined is not unlikely. With an ashpit pressure of 0.6 in. of water, 13 lb. of small anthracite coal is burned per square foot of grate surface per hour. Allowing 18 lb. of air per pound of coal, this is equivalent to 234 lb. of air per hour per square foot of grate. The average thickness of the fuel bed would be about 5 in., the majority of which would be ash. The average thickness of the chimney wall is 22 in., and the draft pressure necessary to force this amount of air through 22 in. of ash would be $22 \div 5 \times 0.6 = 2.6$ in. of water. As the air flow varies as the square root of the pressure, the air passing through the chimney walls, if made of ash, would be $\sqrt{0.6 \div 2.6} \times 234 = 112$ lb. per hour. Assume that the ash is compressed to increase its density to that of brickwork. Its weight when melted into glass is about 180 lb. per cu. ft., when on the grate, 40 lb., and when compressed as suggested, 130 lb. Then the volume of the interstices has been reduced from $180 - 40 = 140$ to $180 - 130 = 50$, so that their volume is $50 \div 140 = 0.357$ of the original volume. As the length of passage remains the same, the area is reduced to 0.357; or the equivalent diameter is reduced from 1 to $\sqrt{0.357}$ or 0.6. The air flow would be reduced to $\sqrt{0.6^5}$ or 0.28, which would bring the air flow down to 112×0.28 or 31 lb. per hr. Further reduction would be necessary owing to the clayey nature of brick material providing much less porosity than the ashes, and to the air being heated during its passage through the walls.

It is not presumed that this discussion leads to anything very accurate; but it shows that the leakage of only 4.5 lb. of air per hour required to meet the theory is by no means unreasonable.

An attempt was made to provide a check by constructing a curve of gas temperature by combining the heat transmission loss and air leakage loss for each 20-ft. section; but the result is not satisfactory. It was thought that if the air leakage was apportioned to the different sections in accordance with the vacuum at those heights and the relative resistance to air flow of the walls of each section, and the corresponding heat loss by transmission added, then the plot of the resulting gas temperatures should agree fairly well with the curve of observed temperatures. The curve computed in this manner is the one marked B, and it does not follow curve 1 as closely as was hoped. It is probable that the discrepancy is due partly to air leaks where the breeching joins the stack, and partly to erroneous assumptions as to the relative resistance to air flow of the different sections of the chimney walls.

If no other heat loss occurred than that due to transmission through the walls, the gas temperature drop would be small. Owing to the higher temperature maintained within the chimney, the heat loss would be a little greater than that which has been calculated, and would amount to 1,290,000 B.t.u. per hr. The temperature would fall according to curve A.

The average temperature with an airtight chimney would be 467 deg., and the resulting draft at 10 ft. above the base of the stack would be 1.42 instead of 1.25 in. of water. In addition to the increased vacuum, the space occupied by the air could be better occupied by flue gases which would increase the capacity of the chimney 25 per cent.

Looking at the case in another way, the draft of 1.25 in. of water would be provided by a chimney 220 ft. high instead of 250 ft.; and the capacity would be met with a chimney 16¼ ft. diameter instead of 18 ft. The saving in the cost of the stack would be about $8000.

It is probable that these figures will apply with some modification to concrete as well as to brick stacks. They are generally approximate since it was not thought worth while to make more refined calculations when the gas weight was not known precisely. But they are sufficiently accurate to demonstrate the great amount of heat wasted, and the economy which would be effected by making concrete and brick chimneys airtight by painting them with a suitable composition.

I'll Say It Is Mended

THE BOSS called Dennis and told him where the gang were at work and asked him to go and ascertain from the foreman if he had cleared the leak in the transformer.

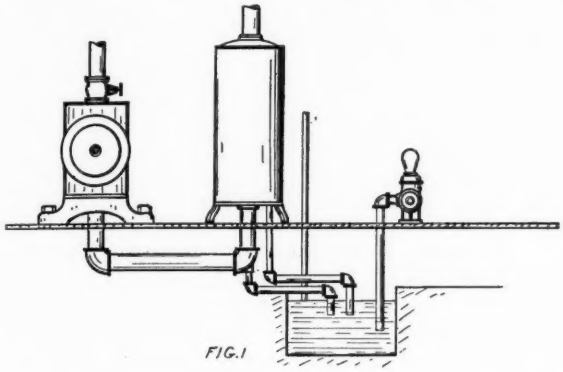
When Dennis reached the place designated, he saw where the gang had been working, but they had departed. In making his report, he said:

"Well, sor, they hov gone, but oi stood benath the iron box wid me face towards the moon and me hands held stretched out like two bird wings and divil a drop of water fell."

Eliminating Cylinder Oil from Exhaust Steam

By W. H. Wakeman

THE engineer of a plant in the vicinity of my engine room became convinced that his boilers were receiving more cylinder oil than they ought to, hence he decided to open them and ascertain their condition. Accepting his invitation to inspect them, and looking



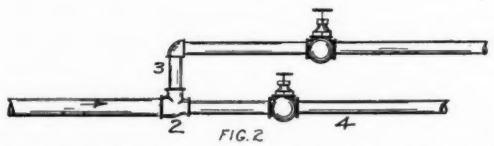


FIG. 1. DISCHARGE OF DRIPS TO HOT WELL, AND SUCTION OF FEED PUMP

FIG. 2. FEED PIPE CONNECTIONS SHOWING FLOW OF OIL

through the manhole below the tubes in one of them, no oil was found on the shell or tubes. The second one was in a dangerous condition, as the tubes were thickly covered with oil, and it was dripping from all of the lower ones to the shell.

Examination of the plant disclosed the following conditions. Drip-pipes from the exhaust pipes of a

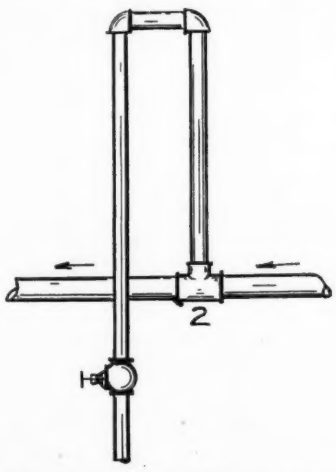


FIG. 3. OIL TRAP FOR FEED LINE

Corliss engine, a closed feed-water heater and from a heating system discharged into a cement-lined cistern under the engine room floor, Fig. 1. There was no separator in the exhaust pipe. This cistern also received rain water as it flowed from the roofs through ordinary leaders. The suction pipe of the pump was arranged as shown, because the proprietor expected that all oil would float on the surface, and that water would be drawn from below the surface. This assumption may have been correct, but frequently the water line was lowered by the pump until the suction pipe drew in the oil and discharged it through the feed pipe. The suction pipe should have been carried to the bottom so that oil would not be drawn in until the cistern was nearly empty, and although this would be far from safe, it is much better than the original, because there is less liability of lowering the water line (or the oil line) to a dangerous point.

The reason for one boiler being deluged with oil, while the other was free from it, was clear when the feed pipe was examined. See Fig. 2. Water and oil flowed through this pipe as indicated by the arrow. When the combination arrived at the reducing tee, 2, the oil went up through 3 as it naturally sought the highest point, and was delivered to one boiler, while comparatively clean water passed through 4 to the other boiler.

Acting on the information secured in this case, I installed the device shown in Fig. 3 in my own plant.

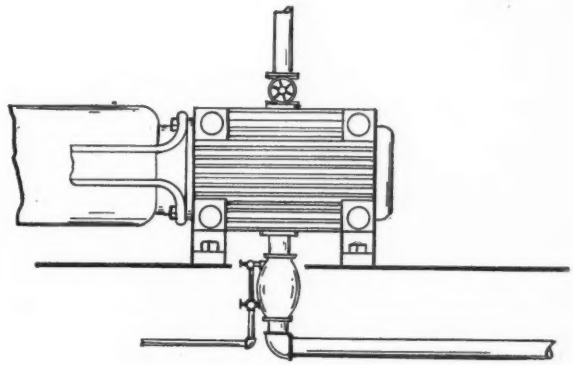


FIG. 4. OIL SEPARATOR TOO CLOSE TO ENGINE

The horizontal pipe represents a section of the main feed pipe through which water passes as indicated by arrows. The tee, 2, looking upward, carries a vertical pipe, an ell, a nipple, another ell and a long vertical pipe, also a valve which remains closed under normal conditions. The horizontal pipe at the right of 2 is several yards long, hence if there is oil in the feed water it has a chance to rise to the top, and when it arrives at 2 it rises into the vertical pipe, and is drawn off through the valve shown, which was located in this position in order that it might be accessible while standing on the floor.

There is no good reason for the dangerous condition of affairs in the above-mentioned plant, which is duplicated, or at least approached in many others. A remedy is found in a good oil separator, of the right kind, properly installed. That there are several right and wrong ways of attempting to secure good results, the following shows.

Figure 4 illustrates a separator located in the vertical exhaust pipe close to the cylinder. It proved a failure, as it did not purify the exhaust steam. The

consulting engineer who recommended this separator specified that it ought to be located farther away, but the steamfitter placed it as shown. When it was taken down and installed farther away it was a success. In the former case, it received comparatively dry steam, but in the latter more or less water was mixed with it. As this was the only change made, the difference in results cannot be attributed to any other cause.

Inasmuch as the manufacturers of some separators advise that they be located near the cylinder, to take oil

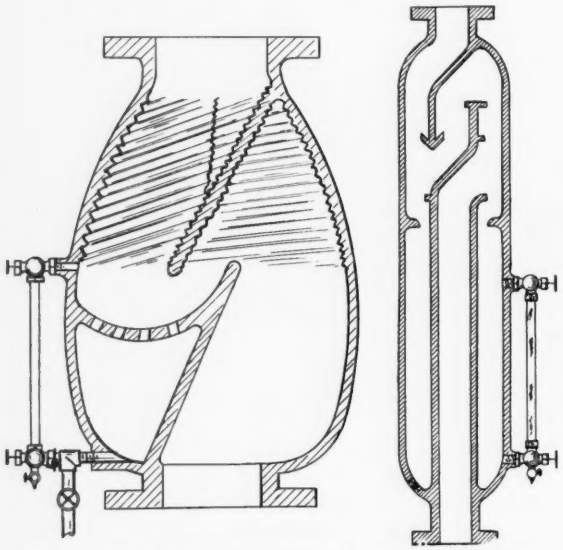


FIG. 5. VERTICAL SEPARATORS FOR FLOW IN EITHER DIRECTION

out of exhaust steam, while others prefer to have them farther away, how can an engineer decide which is best for his conditions? The manufacturers of these appliances guarantee results, hence they should be consulted when a separator is to be purchased, concerning the kind that will give best results, the proper way to install it, etc., and their recommendations ought to be adopted. Failure to do this in the foregoing case was rather expensive, as the separator was in a 10-in. pipe line.

In Fig. 4 the steam travels downward, and should have a separator that was designed for this condition. With the steam moving upward a different design should be used. It is quite evident that if a separator had been designed for one of these conditions, and then moved to the other, it would prove a failure in the latter position. Figure 5 shows separators that may be used for either direction of flow.

In another plant, the engine was fitted with an 8-in. exhaust pipe, and when it was decided to install a separator to remove the cylinder oil, a well known type was selected and connected in a horizontal section of the pipe, but a thorough test showed that it was a failure, as the steam contained oil after passing through it.

Investigation disclosed the fact that the manufacturers did not guarantee their product to remove the oil, if the steam traveled faster than a stated velocity, which was exceeded in this case. The separator was removed and a section of 12-in. pipe, with a 12-in. separator substituted. Although it was the same kind and no other change was made, the results were perfectly satisfactory. This further illustrates the advisability of conferring with the manufacturers.

Due attention should be given to the direction of flow in the horizontal kinds, as well as for the vertical types. Some types can be connected without special reference to this feature as steam may travel through them in either direction with equally good results. In others steam must pass through as designed, or the separator will not remove the oil. It is only necessary to observe the inlet and outlet openings, as indicated by the manufacturers, and connect them accordingly, but this is a very important proviso.

A descriptive paragraph of one of these appliances concludes as follows: "The correct oil separator should be non-fouling, or self-cleaning." This raises the question as to whether a separator should be made so that it can be taken apart and cleaned, or cast in one piece, relying on its operation to keep the internal surfaces clean. Probably more of the latter than the former are in use, but this may be at least partially due to the fact that it is the cheaper form of construction. Figure 6a illustrates a design that admits of internal inspection and cleaning by removing a plug at the top. As it is fitted with screwed connections, it is made only for 6-in. pipe and smaller sizes. Figure 6b is fitted with a flange at the top that can be removed at pleasure, even in the larger sizes, as it is only necessary to take out a few bolts for this purpose.

Proper draining of separators has not always received the attention that its importance demands. In a

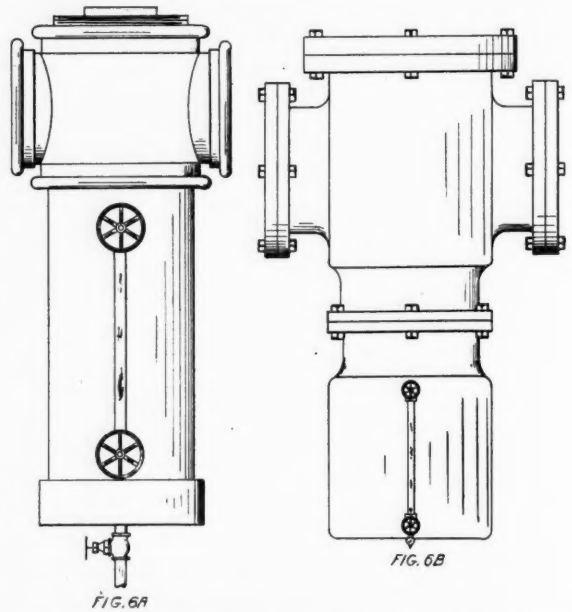


FIG. 6. HORIZONTAL SEPARATORS DESIGNED FOR INSPECTION AND CLEANING

certain plant the operator kept the drip valve on his separator closed for the greater part of the time, only opening it at irregular intervals to allow oil to escape. Of course the natural consequence was that after the drip pipe filled, all oil coming from the engine and pumps passed entirely through the separator, until the valve was opened allowing it to escape, after which the pipe and separator soon filled again.

In other cases the drip valve has been left wide open, thus allowing much steam to be wasted. To modify this waste, drip valves are left nearly closed, but this is not always satisfactory. The best plan is to attach a reliable steam trap to the drip pipe and leave the valve wide open. An intermittent discharge trap is best for this service, if it will discharge at low pressure.

Removing oil from the exhaust pipe of a condensing engine is sometimes a difficult problem to solve, yet it can be done if certain well known principles are duly considered. When a drip valve on such an exhaust pipe is opened, water does not come out, but air is drawn in. This denotes unbalanced pressure, but so long as all joints in this pipe are perfectly tight, the internal operation is the same as with a noncondensing engine. The only difference is that the pressure in the pipe is reduced below atmospheric pressure.

Figure 7 illustrates a receiver separator connected to the exhaust pipe of a condensing engine. The drip pipe is connected to the trap, 2, with a gate valve, 3, in the discharge to the sewer. Under normal working conditions the three way valve 4, shuts off the steam pipe, 5, but the passage to the trap is open. The only special requirement in this case is that every joint must be absolutely tight, and the appliance will work the same as on a noncondensing engine. When 2 is full of water and oil as shown by the glass gage, cock 4 is turned to the right one-quarter turn. This shuts off the separator and admits steam at full pressure to 2 and as 3 is opened, 2 is emptied in a few seconds. By closing 3 and turning 4 back to its original position, 5 is shut off and the apparatus again operates. It has not stopped during the short time required for this change, because the receiver is large enough to hold what water and oil has come over from the engine.

Figure 8 is a more elaborate form of separator for condensing engines, and may be described as follows: Steam at low pressure, water and oil come to the appliance from the left, and purified steam leaves at the right. Some of the water and oil flows along the bottom of the exhaust pipe and falls into the auxiliary chamber, 2, from which it is drained by the pipes, 3 and 4, into the large tank, 5, which in turn is drained by 6.

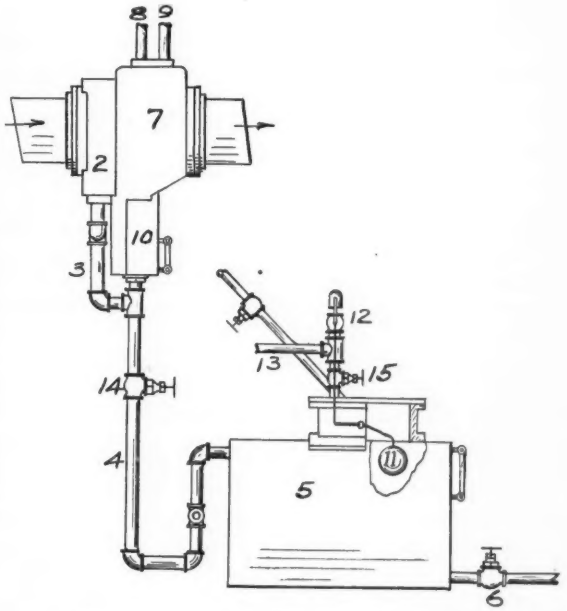


FIG. 8. OIL SEPARATOR FOR CONDENSING ENGINE WITH RECEIVER TANK AND ALARM

The exhaust steam goes into the main chamber, 7, where it comes in contact with baffle plates. If these plates were of the same temperature as the exhaust pipe, the high velocity of the drops of oil would cause them to bound back and again mingle with the steam. To

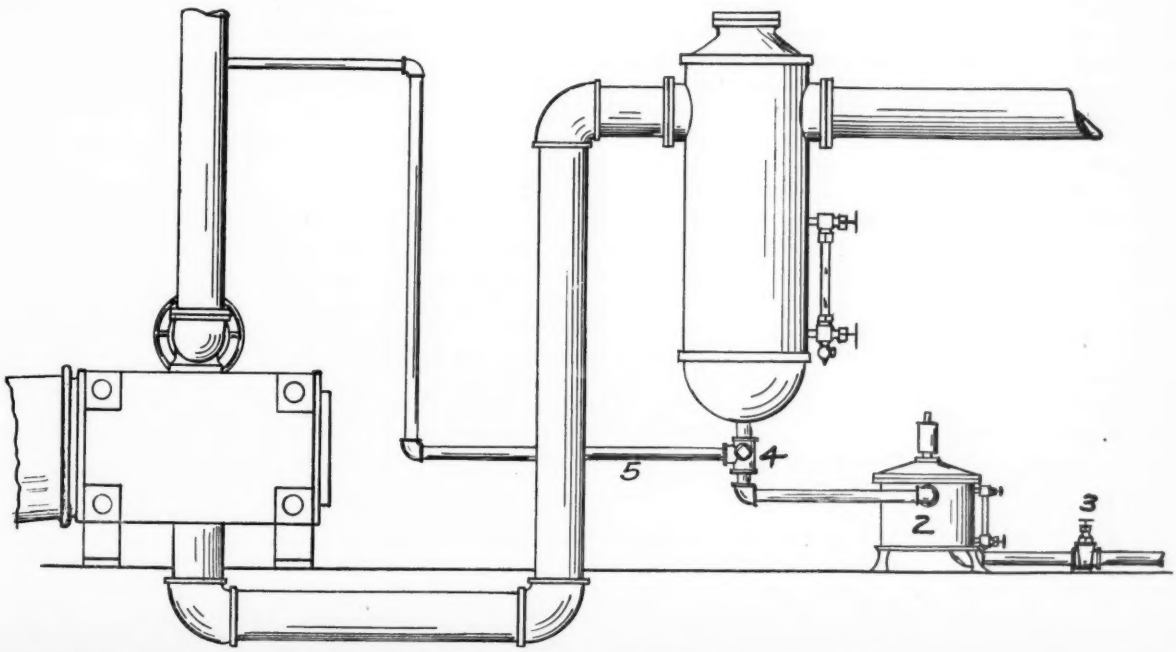


FIG. 7. CONNECTION OF SEPARATOR ON CONDENSING ENGINE EXHAUST

eliminate this tendency, cold water flows in through 8 and passing into a hollow plate is forced out through 9. This moistens the plate and holds the oil until it trickles down into the receiver, 10, from which it is drained through 4 to 5.

When 5 is full of water and oil the float, 11, rises and by suitable levers opens the whistle valve 12, which is supplied with live steam at full pressure through 13; the whistle blows until 5 is relieved. This is accomplished by closing 14 and opening 15 and 6. When the water and oil have gone to the sewer, 15 and 6 are closed, 14 is opened, and normal working conditions are restored.

These are two essential features which must be found in a separator if it is to give satisfactory results: (1) It must change the direction of the flow of steam rapidly; (2) The separated impurities must be kept from contact with the out-going steam, as otherwise some of the oil and water may be taken up and passed out with the steam.

Inspecting the Boiler

WHAT TO LOOK FOR AND WHERE TO LOOK FOR IT. BY W. M. MCNEILL

IN all boiler plants, the boilers are at some time inspected; but judging from some boilers I have seen, one would not think a man had been inside them since the day the rivet bucker crawled out. The tendency, however, to neglect the regular and systematic inspection of boilers is steadily decreasing, which is encouraging.

Boilers should certainly be inspected both internally and externally at regular intervals and the person intrusted with this work should know what defects to look for and where to look for them. In the majority of plants, the boilers are insured, consequently the boilers are inspected occasionally by the insurance company inspector and the reports of these inspectors are very reliable, as men of the highest character and ability are secured for this work and they are usually given special training along this special line of work. The trouble with relying on the company inspector lies in the fact that it is usually from six months to one year between inspections, and in this time, a great many things may happen to a steam boiler to cause serious trouble, if they are not given attention by somebody around the plant. For this reason, some person who has a thorough understanding of the principles involved, should be made responsible for the regular and systematic inspection of the boilers.

It is with the idea of being of assistance to somebody not familiar with this class of work, but who is forced to assume responsibility for it, that the following suggestions are offered.

It is a good idea to keep a note or record book and make a note of the conditions as you find them, for future reference.

On entering the boiler, it should be noted whether or not there is any scale formation, whether it is hard or soft formation, where the greatest accumulations occur and whether the scale is adhering to the metal or if it is loose and ready to fall off. Pitting and corrosion should also be looked for. This usually occurs near the water level, but may be found almost anywhere in the boiler. Sometimes oil will be carried into the boiler with the feed water, the oil being deposited in the heater by the exhaust steam. If traces of oil are found in the boiler, this should be overcome at once by preventing the oil from reaching the heater, as oil will surely cause trouble in the boiler if permitted to reach it in very large quantities.

A very careful inspection of the tubes should be made to ascertain if there are any signs of pitting, corrosion or blistering and if these occur to any dangerous extent, the tubes should be marked and at the first opportunity they should be replaced with new tubes. Blistering is usually caused by scale accumulating on the heating surface and preventing the water from coming in contact with the metal, which, of course, causes overheating, resulting in a blister.

The braces should receive very close inspection to ascertain if they are not loose and that they have as nearly as possible an equal tension. Also the rivets should be examined to see that they are all tight.

One of the most important things in the inspection is the feed-water lines, where they enter the boilers. These will usually be found to contain a great deal of scale, sometimes so much as to interfere with the feed water entering the boiler. These should by all means be kept free from scale as well as other obstructions; this also applies equally to the water column connections. If these be allowed to become filled with scale and mud, it will interfere with the proper functioning of the water column and the firemen can never be sure about the water level. All valves on the water column and feed lines should also receive attention to make sure that they are in good condition so that they may be used when needed.

The blowoff lines and valves should be thoroughly examined. They sometimes become scaled up to such an extent that it is impossible to blow a boiler down as it should be; also it is next to impossible to open the blowoff valves or to close them, when they become clogged up with mud, slime and scale. The blowoff line where it leaves the boiler, is usually exposed to a very high temperature, and due to scale and mud settling at this point, is very likely to become thin and blistered, and may get in a dangerous condition unless given special attention.

The safety valve should not be overlooked as it is the means by which dangerous pressures are avoided; if it fails to work properly, it may mean the loss of life and property. See that it is in good condition, properly set so as to pop at the right pressure. Along with the safety valve, comes the steam gage. A gage should be kept in the plant for a standard, by which all the other gages can be tested. Better still, a test set should be in the hands of every engineer in charge of a plant. Check up the steam gages once every six months at least, and make sure they are right.

In making external examination of the tubes, be sure to notice around the lower ends of the tube, if it be a vertical boiler, for if any water has reached the outside of the tubes and followed down to the tube sheet, you will very likely find that considerable corrosion has taken place at this point. This is caused by the water reaching the ashes which have settled at this point, the water combining with the sulphur of the ashes to form

sulphuric acid, which attacks the iron. The proper remedy for this is to prevent the water from reaching the furnace, that is, the outside of the boiler and the furnace should be kept dry. The only place that water has around a boiler, is inside of it.

There is always a possibility of the boiler settling at some point and causing undue strain, either on the boiler itself or on the steam or water lines, so do not forget to look for signs of this trouble, as a great many plants have been shut down and serious damage done from this cause.

The main thing in the inspection of a steam boiler, as in everything else, is to learn what to look for, where to look for it, and use a little common sense and judgment.

Interpretation of Boiler Water Analyses

ABSTRACT OF A PAPER READ BEFORE THE SPRING MEETING OF THE AMERICAN SOCEITY OF MECHANICAL ENGINEERS. BY J. R. MCDERMET

THIS PAPER sets forth the importance of taking into consideration, when making a feed water analysis, the corrosive properties of the water as well as its tendency to form scale. The interpretation of the various types of analyses employed for this purpose is discussed.

Feed water impurities may be classed in at least one of three groups: dissolved solids, pollution products, and dissolved gases. The dissolved solids which may be determined from a technical analysis group themselves into corrosive and scale-forming constituents. Pollution products are detected by inference from a partial sanitary analysis. Dissolved gas analyses, mainly dissolved oxygen, are discussed in relation to the safe allowable operating limits for feed-water lines, boilers and economizers.

An appendix gives a working outline of the laboratory procedure to be followed in making a complete analysis.

It is pointed out that it is only the relatively pure waters which produce dangerous conditions as far as corrosion is concerned; that as the proportion of dissolved solids decrease, the liability to corrosion and pitting, disproportionately increases. Scale is a fairly effective protection against this form of attack. The presence of organic acids, as determined in a sanitary analysis, effects principally steam lines, turbines and engines, and condensers, where condensation occurs, and not so much the boiler which is reasonably exempt. Nitrogen compounds, especially ammonia, affect largely the copper and brass fittings and turbine parts. In a boiler operated at rating one part per 1000 of oxygen rarely results in corrosion. Boilers operated below rating rarely suffer any damage whatever may be the oxygen content of the feed water. In steel economizers corrosion usually begins with electrolysis. These minute holes offer a lodging place in which bubbles of gas may adhere, causing oxidation of the metal and more serious corrosion.

Explosions in Air Pipes to Blast Furnaces

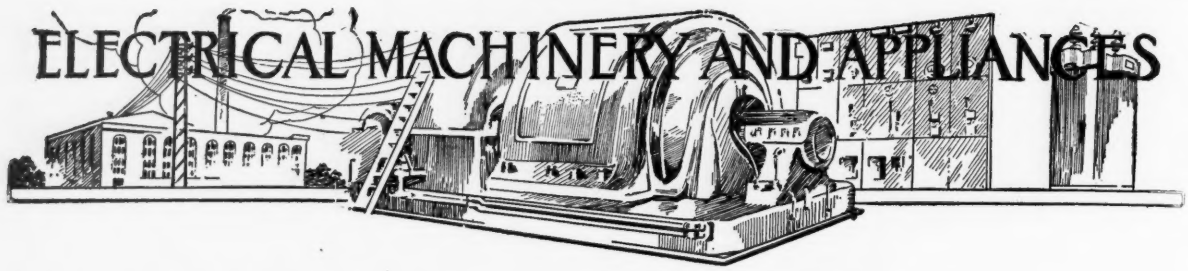
BY J. O. BENEFIEL

THESE explosions are usually caused by gas backing up into the blast pipes when for some reason the fan or fans have been shut down and the gas valve on a furnace has not been closed or leaks badly; when sufficient gas has leaked in to form an explosive mixture, it is ignited from the hot brickwork or from a furnace where the fire has been left burning and the blast gate open. Sometimes the explosives light and only blows the small piping apart; but we have had some that were quite serious, blowing the blast mains down to an extent that shut the shop down for several hours and requiring considerable labor and expense to repair. As a means of preventing these, we placed valves on the gas line where it enters the building with instructions to close this valve at once in case the blast pressure goes off; a reliable workman is appointed to look after this. We have found this to be the best safeguard. We also have several valves on the blast mains that open automatically when the fan stops; these are of the same material as the mains, usually 6 or 8 in. in diameter, set on top of the pipes. The valve is closed and held so by the blast pressure; when the pressure is off gravity causes the valve to open. We consider these to be of benefit, as they cause a circulation of air through the piping; but they are of no use in case of an explosion.

It seems impossible to have the air properly used or the piping taken care of when there are many operatives; a very large percentage of the air is wasted through accidental and intentional openings in the piping, also much gas is wasted by putting on too much air, then turning on more gas to counterbalance the chilling effect of the air. We have closed down both air and gas for an operative who was unable to heat his work fast enough with an immediate improvement in the furnace conditions. Much gas is wasted this way where there are many small furnaces. We have seen some efforts at proportional mixing that looked promising, but a variation in any of the conditions calls for adjusting of the apparatus.

Pre-mixing by drawing the air and gas through an individual fan gives highly satisfactory results both as to heating and economy of gas, but the piping between the fan and furnace should be short and properly proportioned, otherwise there may be a flashback causing an explosion in the fan.

IN ORDER to save workingmen from ill health resulting from insanitary working conditions and to save manufacturers from incurring claims from damages, it is necessary for the Public Health Service to examine physically both the workmen and the plant in which they work. Some manufacturers and many workmen fear examination, believing that it will be used to make trouble for them, and not realizing that undiscovered defects in either plant or man will surely lead to serious results. To such the Public Health Service says that it is strictly neutral and that it will not "tell tales." Its object is to improve the health of the men and to enable the factory to save money by making its employes healthy by giving them healthy working conditions.



Construction of Industrial Electrical Distribution Systems---III

PRACTICAL POINTERS ON THE SUBJECT OF PRESENT-DAY CONDUIT WORK. BY V. E. JOHNSON

PANEL BOXES and boards are obtainable in many different designs. There is no need for a slanting top in a box for conduit work, as the wires cannot be damaged by articles laid on the top. For power distribution switchless boards are suitable, but for lighting panels the switch type is usually used. Figure 31-a shows a panel board and box.

The conduit is secured to the box by means of a bushing and locknut as indicated at the left of Fig. 32.

The main distributing center may consist of a regular switchboard, or it can be a panel board. Sometimes a

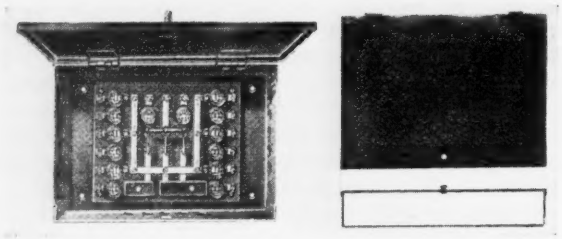


FIG. 31-A. TYPICAL PANEL BOARD AND BOX

separate panel box and board is used for lighting and for power, while at other times one box houses both panels.

The boxes can be supplied with conduit holes cut in them; but many electricians prefer to cut the holes on the job, in that way assuring a perfect fit.

In Fig. 32 is shown an imaginary run of conduit. A, B, C, D, E show methods of terminating a pipe, F and G are methods of making crosses; H and I are methods of making bends. J and K show methods for making connections to leads in a straight run of pipe; L is a junction box; M is a running thread; N is an offset; O, O are lock nuts; P, P are bushings. Fittings such as F, J, K, and L can be used for pull boxes in long runs of conduit, affording places for sectionalizing the wires, and places to fish through.

INSTALLING CONDUIT

IN INSTALLING a conduit system, the following are the various steps in the order usually gone through: cutting, reaming, threading, bending, hanging, connecting, fishing, pulling, and splicing. This article will treat each of these operations in turn and as briefly as possible.

The first three operations can be done either by hand or by machine. When by hand, the cutting should be done with a hacksaw rather than with a pipe cutter, as with the latter a large burr is formed on the inside of the pipe which is rather difficult to ream out. Care should be taken to cut the pipe end square—otherwise, difficulty is experienced in starting the die, and may even result in breaking the latter.

Reaming can be done with a half round file or with a reamer. There are several types of reamers on the market, some being operated by a ratchet which forms a part of the device; others have a square shank and must be used with a brace. The edge should be carefully taken off so that when the pipe butts together inside of the coupling it will not be upset into a cutting edge. See Fig. 33.

There are a great variety of stocks and dies for hand threading. For work larger than 1 in. it is desirable to use a stock with a "screw feed" on it, so arranged that the stock is clamped to the pipe, after which the die is fed in automatically as the handles are turned. This eliminates the trouble in starting which is so often experienced even with comparatively sharp dies. For sizes larger than 3½ in. the use of a geared stock is advisable.

To avoid frequent changes in the "set up" all conduit of one size should be cut at one time. Labor can often be saved by having two (or more) hand dies set for, say, ¾ and 1 in., and cutting the larger pipe in the machine. This way a run of several parallel pipes can be installed simultaneously, saving much trouble in erecting scaffolding and moving ladders and usually resulting in a neater and more symmetrical job.

The methods used in bending conduit depend on the size of the pipe. For example, ½-in. pipe can be bent over the knee or under foot, while 4 and 5-in. pipe requires the use of jackscrews or other mechanical appliances.

If the curve or bend of the conduit must have a definite shape (to fit in a given place or to match adjacent pipes) it is necessary to lay out the curve on the floor with a piece of chalk. Simple elbows can, of course, be made without this precaution if the radius of the curve is unimportant, but in general no close work should be attempted without it.

For bending pipe up to 1 in., a convenient hickey is made out of a short length of pipe and a tee. A little better device is one especially designed for the purpose. It resembles the pipe and tee hickey except that the tee

is open on one side, avoiding the need of passing it down the whole length of the pipe to reach the point for bending.

For larger conduit, the power is applied to the pipe itself which is inserted into a pipe holder similar to that shown in Fig. 34. This is a homemade device consisting of a large and a small grooved pulley. The larger pulley is prevented from turning by means of a bolt near its rim. An iron strap may be used to reinforce the workbench, or the two pulleys may be mounted on some of the structural steel work of the building itself. This arrangement is convenient in that large

There are on the market a number of pipe hangers designed for attaching conduit to the flange of I beams; but many of these are so flimsy as to be worthless for any except the smaller pipe, say ½, ¾ and 1 in. For the larger ones, there seems to be nothing any better than the clumsy old-fashioned pipe clamps, Fig. 36. The engineer can be certain that these will stay in place after installation.

When conduit is run under the roof trusses, a scheme such as shown in Fig. 37 is frequently used and is absolutely safe.

For conduit runs along masonry walls, the most

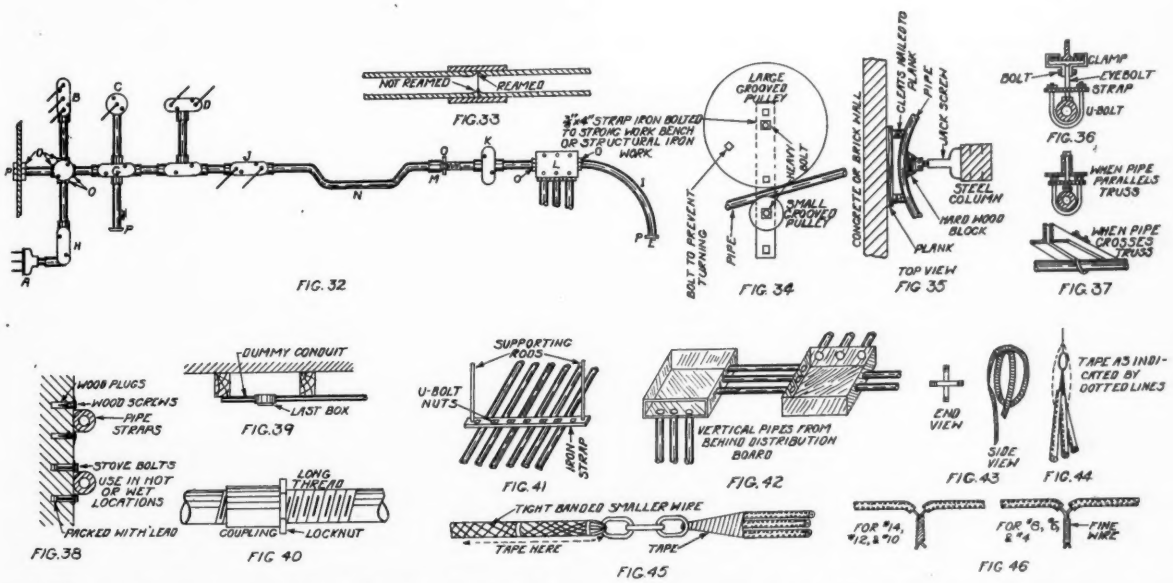


FIG. 32. RUN OF CONDUIT SHOWING VARIOUS TYPES OF FITTINGS EMPLOYED. FIG. 33. ILLUSTRATING REAMED AND UNREAMED PIPING. FIG. 34. A CONVENIENT PIPE BENDER. FIG. 35. USING THE JACKSCREW AS A PIPE BENDER. FIG. 36. THE PIPE CLAMP FOR CONDUIT SUSPENSION. FIG 37. A SCHEME FOR SUSPENSION OF CONDUIT UNDER ROOF TRUSSES. FIG. 38. METHOD OF ATTACHING CONDUIT TO MASONRY WALLS. FIG. 39. METHOD OF "OVER-RUNNING" CONDUIT TO PROVIDE SUPPORT. FIG. 40. ILLUSTRATING "RUNNING THREAD" CONDUIT CONNECTION. FIG. 41. A SUSPENSION RACK FOR CONDUITS. FIG. 42. ILLUSTRATING USE OF LARGE PULL BOX. FIG. 43. SHOWING HOW END OF FISH SNAKE IS BENT. FIG. 44. METHOD OF ATTACHING SMALL CONDUCTORS TO FISH LINE. FIG. 45. FOR HEAVY CONDUCTOR WORK THIS SCHEME IS SATISFACTORY. FIG. 46. EXAMPLES OF PIGTAIL SPLICES.

bends can be made around the large pulley, while small ones can be formed around the other one.

On pipes 2½ in. and up, the use of a jackscrew becomes necessary. Figure 35 shows one way in which this can be done. The cleats and the hardwood block should be grooved to fit the pipe approximately. The conduit should be moved along so that the curve will be symmetrical.

Installing Conduit

In many fireproof buildings, the conduit is in place before the concrete is poured and, of course, in this case there is no problem of hanging to be considered. In mill-type buildings, however, it is common practice to have all of the conduit suspended from the floor beams and roof trusses, none of it being built in, except short lengths leading from motors to their controllers. These are many times installed by cutting a trench in the floor and then filling it with cement, a rather laborious and expensive process.

desirable method is perhaps that shown in Fig. 38. Some construction men prefer to use expansion anchors in place of the leaded hole scheme shown here, and these are very satisfactory if the holes are the right size and the anchor is properly installed.

On wooden beams, the fastening of conduit is simple, as an ordinary pipe strap will fill every requirement.

In addition to fastening the conduit itself, care must be taken that all the fittings are firmly in place. In case an outlet box happens to come halfway between two trusses, it is advisable in hanging small conduit to run a dead piece of pipe to the next beam to serve as a support, see Fig. 39. Connection between lengths of conduit is made by means of ordinary pipe couplings. In locations where it is impossible to turn the conduit, a device known as a "running thread" is used. One piece of pipe has cut on it a thread sufficiently long so that a locknut and a coupling can be completely screwed on. It is then butted against the other pipe and the coupling backed off the long thread onto the ordinary thread un-

til tight. The locknut is then jammed against the coupling to prevent it working loose. See Fig. 40. Running threads should be avoided whenever possible as they have a tendency to work loose. If made with, say, one-third of a coupling (sawed off) in place of the locknut, a firmer job is made; but even with this improvement, the joint is weak.

There are on the market special couplings to take the place of running threads, but for some reason they are not widely used.

In installing several lines of conduit in parallel, it is advisable to run them simultaneously. This makes it possible to produce a more symmetrical job than would result if each line were run along alone. Also, it permits of the economical use of portable platforms on which to work.

In making 90 deg. turns in single runs of large conduit it is usually more economical to use factory ells than to bend the pipe. If two or more pipes run in parallel, a neater job can be made by bending them, as by so doing they can be kept parallel in the curves.

The hanging of such parallel runs can often be facilitated by using a suspension rack such as that in Fig. 41, especially when the pipe is run at some distance below available supports. On side walls such runs can be supported by pipe straps from cleats of 2 by 4-in. wood fastened to the wall by methods similar to those shown in Fig. 38.

Pull boxes of sufficient size to take care of all the pipes in a run may be used to advantage—being both cheaper and more convenient than individual boxes. They have, however, one disadvantage in that trouble in one feeder could be communicated to other conductors. This hazard can be somewhat reduced by taping each conductor with asbestos tape so that a flash in one circuit will not set the other feeders on fire. Figure 42 shows some places where large boxes can be installed to advantage.

The number of pull boxes to be installed in a given run cannot be given in any definite way. It is in general not practical to pull wire past more than the equivalent of four elbows, even in short runs.

Heavy cable cannot be pulled past more than the equivalent of two elbows, and then only if the pipe is roomy. It is better to install too many than too few pull boxes and the engineer who is not certain of his ground would do better by erring on the safe side.

The entire conduit system should be thoroughly and permanently grounded. Clamps are available for this purpose—although in their absence a ground can be made by wrapping wire around a clean part of the pipe and fastening the leads to this. These ground wires should be so located that they will not be knocked loose. In a building constructed with structural steel parts, from which both conduit, and water pipes are suspended, the grounding problem is of course automatically solved, as the hangers and iron form a circuit to the ground.

Pulling Wires

Fishing in the conductors or the pulling rope, if one is used, is usually done by means of a flat steel wire pushed from one outlet to the next. Small wires like No. 14 or 12 can be fastened to a loop in the end of the fish wire and drawn in as the latter is withdrawn. For heavier cable, a rope or heavy iron wire is fastened to the fish wire and pulled into the conduit and this rope then serves for pulling. Figure 43 shows how the end of the fish snake or wire is bent so that it will not catch in the couplings and so as to facilitate progress around elbows in different planes. The wire is heated with a blow torch and bent into two loops, one in a plane at right angles with the other.

In long crooked runs, it sometimes helps to tie an oily rag in the loop, being sure that it will not fall off if it gets caught in a coupling. If compressed air is available, long runs can be quickly fished by attaching a heavy cord (such as a chalk line) to a piece of cloth fashioned into a parachute and blowing this outfit through the pipe.

Figure 44 shows the method of attaching small wires to the end of the fish wire in places where the use of a rope is not necessary. On heavier pulls, a No. 10 galvanized steel wire may be used, the end being made up into a loop onto which the cable is fastened. In pulling several stranded cables into the same conduit (and this makes up the majority of conduit work) care should be taken that the connection does not become too large; it is usually necessary to cut out the "heart" of the cable before making up the outer layers. By removing the insulation far enough back, it is possible to make a long slender connection which will give no trouble.

If rope is used for pulling and there is not room to use a regular back splice or loop, the end of the rope can be prepared by wrapping No. 12 or 10 iron wire around it somewhat after the manner of Fig. 45, leaving a sufficient number of wires looped over the end to stand the pulling strain. The cable is then attached to the end of the two or three link chain, as shown.

In feeding in several cables or wires, care must be taken to keep them from crossing as they go in. This crossing would make a "bump" which would increase the difficulty of pulling, and on which the insulation would very likely be injured. Powdered soapstone should be applied to the cables as they enter the pipe, and also blown into the latter. This serves as a lubricant and overcomes the stickiness of the insulation.

The Underwriter Rules provide that wires installed in vertical pipes must be supported at intervals as indicated in this table:

No. 14 to 0 inclusive, every	100 ft.
No. 00 to 0000 inclusive, every	80 ft.
Above No. 0000 up to 350,000 cm., every	60 ft.
Above 350,000 up to 500,000 cm., every	50 ft.
Above 500,000 up to 750,000 cm., every	40 ft.
Above 750,000 cm., every	35 ft.

These supports may consist of a 90-deg. turn in the conduit itself or in various kinds of clamping devices located in junction boxes.

On account of the limited space in junction and pull boxes, splices cannot always be made in the same manner as in open wiring. Particularly is this true for the smaller sizes of wire. Mechanical strength is of no great importance, as the conductor is subjected to no strain of any kind.

Small and medium wires are therefore usually pigtailed as shown in Fig. 46, care being taken that the end

of the "tail" is carefully insulated, as it is this tail that usually breaks through. There are on the market rubber sleeves for slipping over "pigtailed" wires; these save both space and time.

Larger conductors are best spliced by means of sleeves as in Fig. 22.

In soldering, an iron should be used if possible; but in the larger sizes where the torch is necessary, asbestos shields should be used to avoid damage to the insulation. It is often possible to pull the conductor on which work is being done away from the others; this will facilitate the work and result in a better job.

Applying tape in a pull box is often a tedious job, due to the cramped space. A good deal of trouble can be saved by tearing off a suitable length of tape and rolling this up into a small ball which can conveniently be passed between and around the conductors.

There are a number of applications in which neither open nor conduit wiring will be satisfactory. Some chemical plants, for example, are so filled with corrosive vapors that both pipe and wire coverings are destroyed. In such places, many special schemes are made use of. For example, fiber duct such as is used for underground service may be installed with the ends sealed, this protecting at least the position of the conductor in the pipe. Such ducts must be supported by planks or beams, these in turn being coated with tar or some special compound. All of these are at the best makeshifts.

Commutator Maintenance of Synchronous Converters

By R. H. Newton

THE creditable performance of a large synchronous converter is as much dependent upon the condition of the commutator as upon any other one item. It should also be borne in mind that a commutator only becomes thoroughly "seasoned" (the insulation baked out and all parts in their final set position) after operating in service for a considerable time, followed by some tightening and grinding. Owing to lack of facilities for

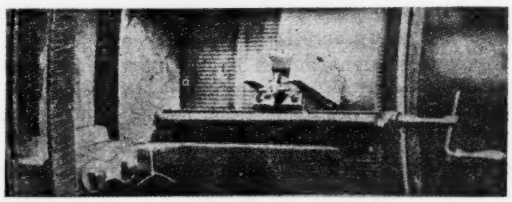


FIG. 1. GRINDING DEVICE FOR TRUING COMMUTATORS

heavy current loading at the works, it is not feasible, in all cases, to season large commutators completely before shipment. It should be expected, therefore, that a certain amount of tightening and grinding will need to be done after the converter is put in service, particularly if the commutator is of large size.

The indication that the commutator needs attention will usually be manifested by a general unevenness or roughness caused by high or low bars.

In exceptionally bad cases, where flat spots exist, or there is eccentricity, it may be necessary to use a turning tool, but for ordinary cases a grinding tool, Fig. 1, is preferable and is recommended. Commutators should always be ground at full normal speed. In cases where converters are motor started, the starting motor can readily be utilized for grinding.

On self-starting converters, a shaft extension is provided on the alternating-current end for mounting a pulley to drive the rotor for grinding, and where possible to do so, it is preferable to grind by this procedure. Where it is not feasible to mount a pulley for separate

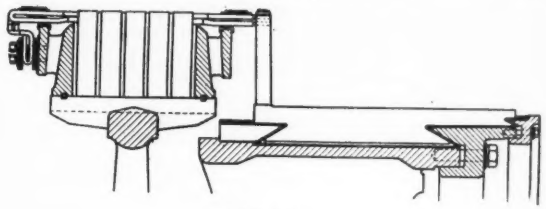


FIG. 2

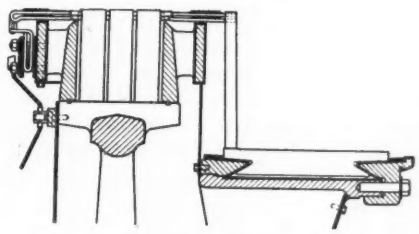


FIG. 3

FIG. 2. SECTION OF COMMUTATOR SHOWING AUXILIARY V-RING

FIG. 3. SECTION OF COMMUTATOR SHOWING V-RINGS

drive grinding, the rotor can be driven at synchronous speed from the starting taps on the transformer, if it is an alternating-current self-started unit, or on reduced direct-current voltage, if it be a direct-current started unit. Great care is, of course, necessary in grinding, when running a converter under its own power, due to the voltage between commutator bars.

In cases where grinding is done by driving from the direct-current side, just as few brushes as possible should be left down for carrying current into the armature. Ordinarily, half of the brushes on two adjacent arms are sufficient. This permits grinding half of the face of the commutator at a time, leaving the brushes down only on that part of the commutator where the stone is not working. All brushes used, however, while grinding is being done in this manner, should be thoroughly cleaned off before the machine is again put back in service, as some copper and stone dust is sure to become imbedded in the face of the brushes. This will not only cause rapid wear of the brushes themselves, if it is not cleaned out, but will also scratch and otherwise damage the commutator and impair commutation. In grinding the commutator when running from the direct-current side, it is well to provide some sort of an insulated platform for the operator. In case it is found necessary to mount the grinding tool on the positive arm of a machine having the negative grounded, it is also desirable to arrange for insulating the tool, as an extra precaution for protection to the operator.

Before grinding a commutator, the machine should

have been in service a sufficient length of time to bring the temperature of the commutator up to a constant value of at least 100 deg. C. The machine should then be shut down and the bolts holding the commutator V ring, shown in Fig. 3, should be tightened.

In tightening commutators having the double V construction, shown in Fig. 4, the outside or auxiliary V bolts should always be backed off slightly, say one-half turn, before attempting to tighten the bolts of the main V. After the machine is given its final tightening, it should be run for at least 12 hr. to reach a constant temperature on the commutator of at least 100 deg. C before grinding. The commutator should then be ground down to a true surface.

In finishing off a commutator, emery cloth or paper should never be used on account of the continued abrasive action of the emery which becomes imbedded in the copper bars and brushes. Even when using sandpaper on a commutator, the brushes should always be raised, and the commutator wiped clean with a piece of canvas lubricated with a small quantity of vaseline or oil. Cotton waste should never be used, and an excess of any kind of lubricant should always be avoided.

The Electric Journal.

Industrial Underground Cables

FACTORS AFFECTING RELIABILITY AND HEAT DISSIPATION; SURVEY OF SYSTEM. BY W. B. DEMUTH

THE underground electrical distribution networks of large industrial plants have received less attention than those of the central stations, with the result that they often give more trouble, cost more to keep up and do not allow all the benefits that might be derived from them and their investment. The following applies particularly to the underground network of steel mills; it applies to any underground system, however.

Industrial underground cables are often laid in trenches and covered with earth without other protection; perhaps a board is placed above them. The cables are more easily damaged, therefore, than when conduit is used. Usually the minimum depth is used, another

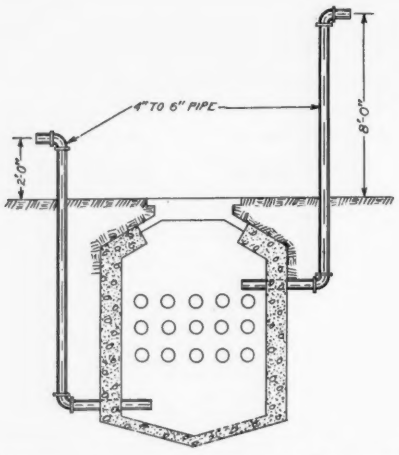


FIG. 1. NATURAL DRAFT VENTILATION OF MANHOLE USING CHIMNEY EFFECT

factor responsible for many forms of injury. Cable routes should be chosen where excavation will not interfere with traffic and similar activities, a condition that is often overlooked until too late.

Even when no conduit is used, junction boxes should be installed at convenient locations to expedite removal of cable and the checking of cable temperatures. Attention to grading is a matter concerning other matters than that of drainage. Where heavy grades exist, often due to careless excavation, it is not infrequent to find that the impregnating compound has seeped down to the lower sections of cable, causing the upper section to become dry, overheat and fail. This condition is to be specially guarded against where the operating temperature is high.

SOIL CONDUCTIVITY

HEAT GENERATED in the conductors is transmitted to the soil and is so conducted away. The soil is thus important, since it determines the safe loading for the conductors. Soils vary with location and the heat conductivity of a soil will vary with the seasons, depending upon the moisture content. It is a good policy to take note of the soil during the excavation of the trench, keeping a map showing where clay, sand, ash, etc., exist. These data may prove invaluable some time in showing the cause of cable failures, in suggesting where "hot spots" may exist and in suggesting safe temperatures that may be maintained.

Around steel mills, considerable ash and clinker are encountered. This is often used as filler for cable ductways. Ash, when wet, is a good heat conductor, but is quite corrosive; when dry, it is a very good insulator of heat because of the air spaces, therefore, ashes around cables tend to be treacherous. Another fact taught by experience is that with wet ash, the heat conductivity is high; the passage of heat dries out the moisture and so heat transmission almost ceases. This condition is responsible for many erratic cable behaviors.

If possible, cables should be run through the same strata of soil, and at sufficient depth to assure safety from pressures and attack from above and to assure ample heat dissipation into the earth. A soil may be quite cool 6 ft. below the surface; the same soil 3 ft. down may be quite hot during the summer in exposed places.

COOLING CABLES

WHERE cables are laid in the earth and directly covered, the soil constitutes the only medium for heat dissipation. Where ducts or conduit is used, heat may be dissipated much more rapidly and by natural or artificial methods.

With any line of cable duct there is always the "chimney effect" due to the fact that hot air rises. The circulation of air through the ducts from this cause may be an important factor in the life of a cable and in determining the safe current density to use. It is important that free passage for the air exist otherwise air pockets will form; and air is one of the best heat insu-

lators known. Air enters through holes in the manhole covers and leaves in the same way. The writer has known cables to overheat and break down for the reason that the holes in the manhole covers had become frozen up in winter and clogged up by mud in the summer after a rain storm.

Manhole cover holes or vents should be kept open not for ventilation alone, but because a manhole explosion may cause the building up of high pressures if there is no ready escape for the gases.

As the chimney effect of cable ducts depends upon the temperature difference of the air inside the duct and outside the duct, it follows that the ingoing air should be as cool as possible. One way of accomplishing this is to increase the height of the stack much as is done in the power plant. The arrangement shown radically increases the air flowing for a given duct temperature, so increasing the velocity of air passing through the duct and the ventilation, therefore. The use of pipe as shown has been used to great advantage in many instances, increasing the current-carrying capacity of the cables from 5 to 10 per cent. A 4 to 6-in. pipe should be used, about 6 ft. high.

The same principle, but a less effective way of carrying it out, consists of installing a canvas shaft around a manhole similar to that employed by cable splicers in the cities during windy and wet weather. The pipe is the better solution, of course.

Forced draft for cable ducts by means of blowers is often resorted to, especially where the load is exceptionally heavy or during the hot summer months. The writer knows of several instances where a motor-driven blower is mounted upon a portable truck which is moved around according to the need for it. This blower outfit is placed over a manhole, a canvas hood is dropped over the manhole and blower connection and the motor started up. The air may be forced through the ducts or sucked out—forced or induced draft—according to circumstances. Forced draft is probably preferable unless special provision is made against air infiltration from distant duct sections.

In one severe case of overheating on a certain company's underground system thirty-eight cable failures were produced between June 1 and October 1 of one year. A survey of the system was immediately planned, but for immediate relief, forced air ventilation was experimented with and utilized by the installation of motor blowers. By the use of this forced draft system duct temperatures were decreased from 52 deg. to 35 deg. C. and were generally maintained within a few degrees of the atmospheric temperature. Permanent relief was obtained in two ways: (1) Additional subways were constructed paralleling the old and a portion of the cables were transferred thereto; (2) load was reduced on cables by installing additional lines.

Some of the central station companies have adopted a direct-connected motor-driven blower installed upon a manhole cover. All that need be done is to take off a manhole cover and replace it with the cover upon which the blower outfit is mounted. In using forced draft it is well to assure that the air will pass through the ducts carrying the cables and not through the ducts that are empty which offer the path of least resistance. Empty ducts can be stuffed with cloths or wooden plugs during the time of mechanical draft.

Water is sometimes used to lower duct temperatures. At first sight it would appear, perhaps, that water would be less troublesome and more efficient than air as a cooling medium. The use of water in any quantity introduces troubles for disposal; it may cause sinking of the earth and settling of duct lines; silt may cause clogging of the ducts with all its attendant difficulties. Air is preferable to water unless special provision has been made for water cooling.

Giving the Duct Line the Once Over

With business quiet, the present is very opportune for giving the underground distribution system the once over and making whatever changes will be beneficial while they can be made most conveniently. Tests that might enable big savings could now be carried on.

For example, it is generally considered that 85 deg. C. is the safe operating temperature for low-voltage cables. This is being exceeded in many cases safely. What is the maximum safe operating temperature of your cables; what is the relation between the loads of the different cables in the network and adjacent to one another? Do you know where the hot spots occur? Do you know where to suspect them?

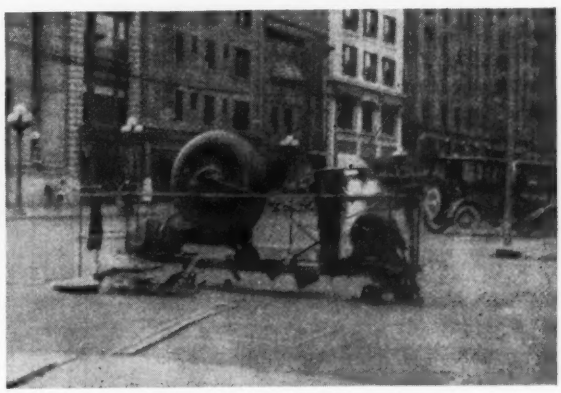


FIG. 2. PORTABLE BLOWER USED TO INCREASE CAPACITY OF UNDERGROUND LINES DURING HOT WEATHER AND OVERLOADS

How about electrolysis, a frequent cause of cable troubles around steel mills? How about temperature surveys? Have you any provision for making them; and would you be able to interpret their true significance?

The central stations have found that with high potentials, the dielectric loss due to potential alone may cause cable breakdown after a certain temperature has been attained because the dielectric resistance decreases rapidly as temperature increases. They have learned that the remedy is to take potential off a line under these circumstances; and operate a cable intermittently. Many steel mills and others might follow this example.

A little attention and a little ingenuity devoted to the underground distribution network would for many large plants bring about increased current-carrying capacity, decreased repair costs, reduced service interruptions and better all-round performance. Now is the time to attend to this matter, in readiness for the days when competition is keen and business brisk, when economy and reliability will count heavily.

Foundations

TEMPLATE, FORMS AND PROCESS FOR MIXING AND PLACING CONCRETE. BY J. C. HAWKINS

IN BUILDING the foundation for an engine or other machine, care must be taken if the work is to be cheaply and well done. Location should be chosen so that all parts will be accessible, and so that any part of the engine can be removed for repair or replacement without disturbing the walls of the building or interfering with other machinery.

Blueprints showing the size of foundation required and location of holding down bolts is usually furnished by the maker of the machine, but it is necessary to make a template to support the bolts in the proper position so that the engine or other machine will be alined to shafts or other machinery to which it is to be connected or related. The blueprint should show also how far bolts are to project above the foundation, location of pits for flywheel or pulleys, and trench for piping or wiring, and for an engine the height of exhaust and steam pipe flanges above the floor of the room.

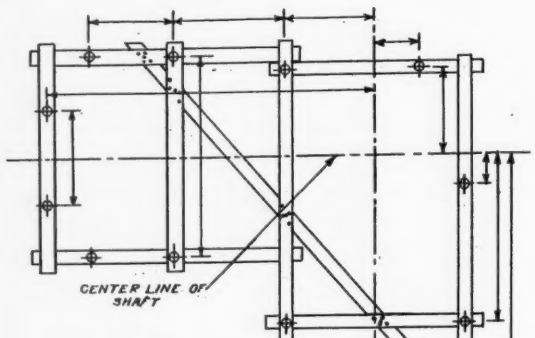


FIG. 1. TEMPLATE FOR LOCATING ENGINE FOUNDATION BOLTS

Depth to which the excavation is carried will depend on the nature of the soil. Six feet may be sufficient for a 200 hp. engine if the soil is firm at that point. In soft soil it will be necessary to go deeper, or even to drive piles down to hard soil.

While the excavating is going on, have the template for the foundation bolt holes made. For a small engine, dressed 1 by 6-in. lumber will be strong enough, but for a large engine this should be 2 by 6 in. A sketch of a template is shown in Fig. 1. Have the template well braced to prevent its being sprung out of shape. Lay off

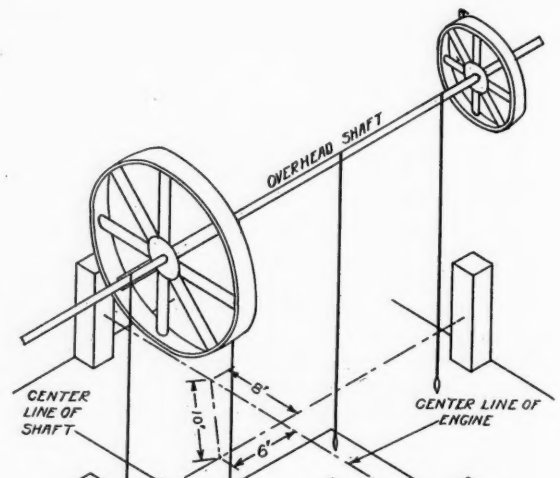


FIG. 2. METHOD OF LINING UP A CENTER LINE PARALLEL TO A DRIVEN SHAFT

Before doing any excavating run two lines from permanent points, one to designate the center line of the cylinder and the other the center line of the shaft. Make these lines long so that the point of attachment will be well out of the way. A block of wood fastened to the wall, with a nail driven at the proper point for fastening the line is a good way; then the line can be moved out of the way when not in use. If the engine is to drive a line shaft, the center line of the cylinder must be set with reference to the shaft. Mark off on the ground the shape of the foundation required, having it square with the center lines and start the excavating. If the soil is firm, the sides of the hole can be trimmed smooth and no framework will be required to hold the concrete, which in these days is universally used on account of its adaptability for this purpose. If the sides of the excavation cave in, forms will have to be put up to retain the concrete.

the center line of the cylinder and also the center line of the shaft on the template, making these lines plain so that they may be easily seen in lining up. From these lines lay off the location of the foundation bolts, and bore holes at these points for the bolts to pass through.

After the excavation is finished, put the template in place using I beams, railroad rails or timbers to hold it in position. The height at which the template is placed will depend on the foundation. If the foundation is all the same height have the template level, and with the bottom at the height to which the concrete comes. If one part is to be level with the floor, and another part extends above the floor place it at the floor line, and after the work has progressed to that point it may be removed and a form made for the part extending above the floor.

To set the template put up the center lines first set, level up the template and bring the center lines of the

template to these stretched lines. If, however, the engine is to be belted to the line shaft, and the first lines run are not accurate it will be necessary to line the template up closely with the shaft. A surveyor's transit is the best for this purpose, but usually one is not at hand, if not, locate a line parallel with the shaft by dropping plumb lines from the shaft, then at the proper height stretch a line parallel with the shaft by means of the plumb lines. If the shaft is not all the same size, allowance must be made for the difference in diameter in locating this line. Stretch another line at right angles to the first for the center line of the engine cylinder. To get these lines square with each other, the surest way is to measure off a distance of 6 ft. on one line and tie a string at that point, then measure off 8 ft. on the other line and tie a string at that point, then move the engine center line until the distance diagonally between the marks is exactly 10 ft. If in doubt of the correctness of this, measure the other angle which, of course, will be the same if the work is correct. Figure 2 shows how this is done. Use a stout fine line, or better, a fine piano wire, and draw it tight; then fasten the end securely if you want it accurate. Move the template until its center line is parallel to this line. Level the template and nail it to the supporting timbers which must be braced to prevent its being moved.

Next put in the foundation bolts. Usually a cast-iron plate about 10 in. square is placed on the lower end of each bolt with a recess to hold the nut. The lower end of the bolt should be pointed so that it may easily enter the nut if taken out for any purpose. Determine from the blueprints how far the bolts should project above the base line to reach through the engine bed, and cut a piece of pipe of such size and length that it will slip over the bolt and hold it up to the required height with the nut and washer on. Sometimes the bolts are not all required to be the same height above the base line, and if the template is set with the bottom at the base line the work is much easier than it otherwise would be. Next cut pieces of 3-in. or 4-in. pipe (old boiler tubes are as good as anything) long enough to reach from the cast-iron plate to within 1 in. of the base line to allow the bolts to be moved if necessary in setting the engine. Put the bolts and pipes in place and screw the nuts on the full thickness of the nut.

After getting all the bolts in place, go over the work again to see that the work is correct. Where all parts of the concrete are level, this is an easy matter but, if one part extends above the rest, it may cause some trouble to the man with little experience in this work to get them all at the proper height. The blueprint will show how high the bolts are to project above the floor line and also above the top of the foundation. If the weight of the bolts and pipes causes the template to sag, it should be blocked up. If this is not done the bolts may be too short when the work is finished. Cut out a round block that will fit the top of the pipe and bolt to hold the bolt central in the pipe and also to prevent its being filled with concrete. Figure 3 shows the template set ready for the concrete.

While the excavating is going on the material for making the concrete should be gotten ready. The location of the plant where the engine is to be erected will control to some extent the ingredients used in making the concrete. The coarse aggregate should be either crushed granite, trap rock, slag, hard limestone or gravel. What to use will depend on what is easiest obtainable and cheapest in that locality. The pieces should range from the size of a walnut to the size of an egg. The sand should be clean and sharp, and in such proportions

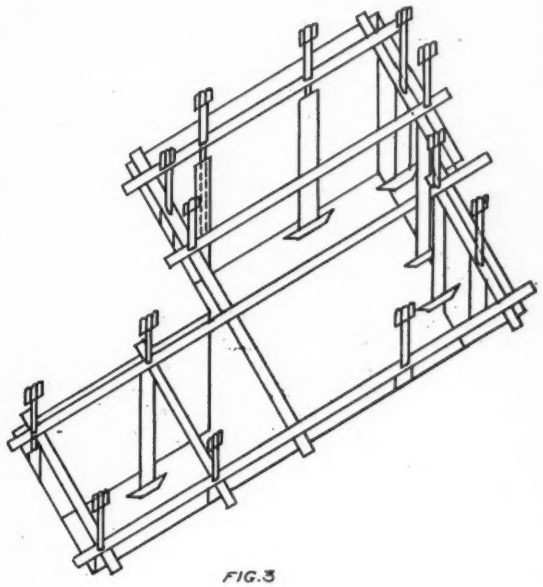


FIG. 3

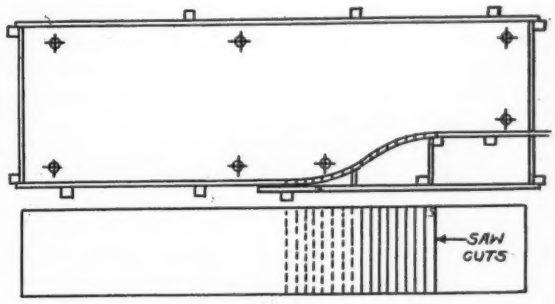


FIG. 4

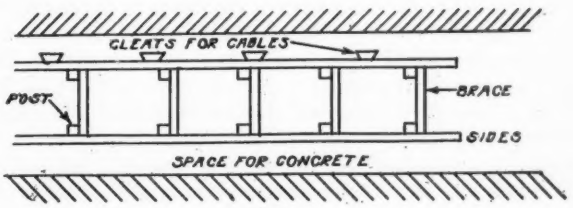


FIG. 5

FIG. 3. TEMPLATE SET IN POSITION READY FOR THE CONCRETE

FIG. 4. CONSTRUCTION OF FORM OF IRREGULAR SHAPE

FIG. 5. FORMS FOR CONCRETE TRENCH WALLS FOR PIPING OR ELECTRIC CABLES

that it will fill the voids between the stones. By clean sand is meant sand free from clay. The voids between the grains of sand should be filled with good portland cement, having the cement slightly in excess of the amount required to fill the voids to give additional adhesive properties to the combination. Avoid soft

sandstone and soft or dirty shale or gravel if a good job is desired. In estimating the amount of material required do not make the mistake of thinking that six barrels of stone, three barrels of sand and one barrel of cement will make 10 barrels of concrete, because the sand fills the voids between the stone, and the cement fills the voids between the grains of sand, therefore, the total quantity of concrete will be only slightly in excess of the original quantity of coarse aggregate.

For a foundation which is subject to vibration, as is an engine foundation, the proportion should be about 1:2:4, that is one barrel of cement, two barrels of sand and four barrels of stone. The cement usually comes in bags, four of which equal one barrel. With this proportion 1 cu. yd. of concrete will require 1½ barrels of cement, 3⅓ barrels of sand and 6¼ barrels of stone. As sand and stone are usually purchased by the cubic yard, one barrel may be considered as equal to 3.8 cu. ft., or about seven barrels to the cubic yard. Another mixture which is suitable for foundations not subject to vibrations is 1:2.5:5 which will require 1.3 barrels of cement, 3.3 barrels of sand, and 6.5 barrels of broken stone for 1 cu. yd. of concrete. All the ingredients should be measured. A convenient method of measuring sand and stone is a barrel with the heads out. Usually, however, the sand and stone has to be brought to the mixing board in a wheelbarrow and one of known capacity makes a convenient method of measuring the sand and stone.

Mixing should be done on a flat platform about 16 ft. square placed as near the excavation as practicable to facilitate getting the mixture into place with the least handling, and should be mixed in the following manner. Measure the sand and spread it in a layer of even depth on the board. Place the cement on top in an even layer and turn it over with shovels at least three times or until the two are well mixed, which will be shown by the even color. Spread it out even and put the stone which has been thoroughly wet on top, and turn three times more, adding water slowly with a bucket on the second turning, sufficient water being used to give a "mushy" mixture. Do not use a hose to supply the water as much of the cement will be washed away, and too much water will be used. Do not mix too much at one time as it requires more labor, and will not be as thoroughly mixed, and should be used before it begins to set. A quantity requiring one barrel of cement is a convenient amount.

In putting the first batch in place care should be taken to work it around the foundation bolt plates if they extend to the bottom, also see that the bolts hang plumb, and about central in the pipes. Place the concrete in layers about 8 in. thick, and tamp it until water comes to the top. If the concrete cannot all be placed in one day, wet the top thoroughly before starting the next day.

When the template is set at the base line, the concrete may be brought up to within 1 in. of the bottom. If the flywheel, exhaust pipe or any part of the frame extends below the floor a frame of the proper shape must be made and set when the work has progressed to that point. The size and shape of these frames may be determined from the blueprint, making these forms of smooth lumber, well braced and with few nails so that they may be readily removed after the concrete has set. Leave the top of the rough work 1 in. below the proper level, for grouting under the bed. All exposed parts should be given a finishing coat, which is made of one part cement and one part sand, and may be colored if desired.

After the concrete is all in place, remove the template and timbers. In some cases part of the foundation extends above the floor line, and may be of irregular shape or curved on one side, in which case a form of the proper dimensions must be made, and set in the proper place. The blueprint will show the size and shape of this form, and also its position with reference to the center lines. The form should be made of smooth lumber to give a good surface to the finished work. Any curved part of the form may be made by making saw cuts partly through the board about 2 in. apart, which will allow the board to spring to the proper shape. When the concrete is put in this form, work a flat spade or a piece of flat iron up and down between the concrete and the form. This will work the stones back, and give the outer surface a better appearance. Figure 4 shows the construction of this form.

When putting in concrete in cold weather where there is danger of its freezing, or where the material is frozen use hot water in mixing and keep a fire burning to prevent freezing, as frost will prevent the work from properly bonding together, and the mass will be brittle. On the other hand, when the temperature is very high the surface will dry quickly, and will be liable to crack, which may be prevented by thoroughly soaking it with a hose once or twice a day for several days. The length of time required for the work to set before the engine is placed upon it will depend upon the size of the block and whether the work is being hurried. Two weeks might do for a small foundation but three weeks or longer is better.

When putting in the foundation have the trench for the exhaust pipe dug and also for the cables to the switchboard if the engine drives a generator, so that the concrete may all be put in at one time. Make the trenches wide and deep enough to give plenty of room for installing the work. Forms will have to be made to hold the side walls of the trench, and may be of 1-in. lumber surfaced on one side having the cleats on the trench side, and bracing one against the other. Make the side and bottom walls about 4 in. thick unless the trench is very deep, and use a leaner mixture, say 1:3:6. If the trench is to be covered over with iron plates leave the top of the wall low enough to provide for this. Figure 5 shows the construction of the forms for the trench. When it is desired to hang the cables on the side of the trench, pieces of 2 by 4 with the edges chamfered, may be fastened to the concrete side of the forms, and the concrete tamped firmly around them. These will remain in place for attaching hooks or frames.

Friendship

OH, THE COMFORT—the inexpressible comfort of feeling safe with a person, having neither to weigh thoughts nor measure words, but pouring them all right out, just as they are—chaff and grain together—certain that a faithful hand will take and sift them—keep what is worth keeping—and with the breath of kindness blow the rest away. —Dinah Mulock.

"LOSE one hour's work in the morning and you will be all day hunting for it."

Faulty Pipe Layouts

THOUGHTLESSLY WORKED-OUT LAYOUTS THAT CAUSE TROUBLE AND EXPENSE. BY H. A. JAHNKE

MUCH HAS been written on the subject of faulty pipe work, and the writer believes that it is instructive and of much benefit, as it shows up some of the faults in piping arrangements he has seen and how the work could or should have been done so as to save much extra material, time and labor. Besides, in many instances, the apparatus to which the pipe is connected would have given better results.

It is the writer's practice whenever visiting any power plant to pay close attention to the piping arrangements throughout the plant, such as the steam, water and air lines, from the point where they start up to where they end, and he has seen some queer-looking layouts such as in trying to get by or around some obstacle to reach the desired point.

Figure 1 shows an arrangement where the fitter, in trying to get by a 4-in. pipe, used as a post in the building, had used a number of elbows and nipples in order to accomplish this, whereas if two 45-deg. elbows had been used as shown in Fig. 2, the appearance of the job would have been much better, besides one elbow and nipple would have been eliminated; also there would have been in this layout only five joints, whereas in Fig. 1 there are seven joints, hence more opportunities for leaks, which we all like to avoid wherever possible. It seems as if some pipe fitters and engineers do not take this into consideration when fitting up a job. It is a much better plan always to have in mind that the fewer joints there are, the less liability there will be for leaks.

Figure 3 illustrates another instance where a fitter in getting by an obstacle which happened to get in his way used a number of elbows and nipples. It is good practice before making a turn around an obstacle where we at first think a number of elbows are necessary, to turn some fitting so that it faces in different directions to see if the turn can not be made with fewer elbows than we think ought to be used. For instance, in Fig. 3, had the elbows been turned a little sidewise, shown in Fig. 4, the turn could have been made with one less nipple and elbow.

Figure 5 shows the main steam pipe furnishing steam to the engine in a manufacturing plant. A branch from this pipe also furnishes steam to the factory as shown at A. The pipe fitter in arranging the layout connected the pipe leading into the factory midway between the tee and elbow; he also connected a drain into the tee to keep the pipe clear of condensation. The drain was connected to a steam trap which discharged the condensate into the sewer, hence this was a total loss to the concern.

Now, had this pipe fitter or the management given this matter a little thought, the pipe layout could have been arranged as shown in Fig. 6, where the steam pipe

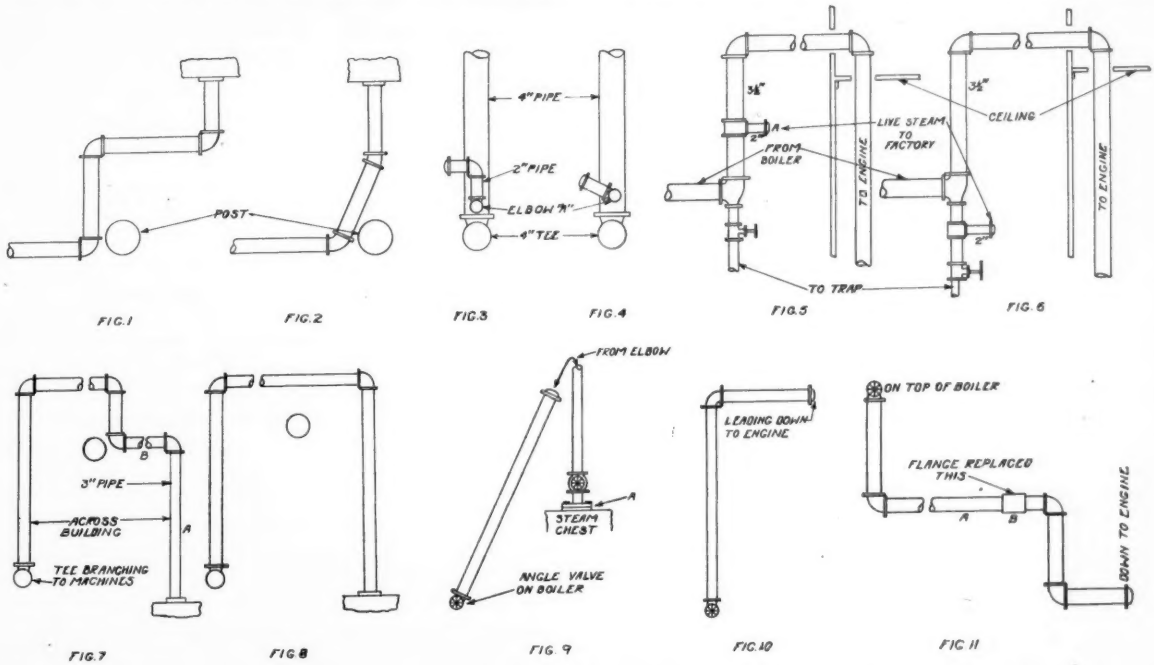


FIG. 1. METHOD OF PASSING AN OBSTACLE AS INSTALLED. FIG. 2. CORRECT METHOD OF LAYING OUT THE PIPING. FIGS. 3 AND 4. WRONG AND RIGHT WAY OF INSTALLING A TOP LINE. FIG. 5. INCORRECT METHOD OF TOPPING A STEAM LINE FOR HEATING PURPOSES. FIG. 6. CORRECT METHOD OF MAKING THIS INSTALLATION. FIG. 7. OFFSET CAUSED BY POOR PLANNING. FIG. 8. HOW THE LINE WOULD HAVE BEEN LAID WITH A LITTLE FORESIGHT. FIG. 9. STEAM LINE AS INSTALLED WITHOUT PROVISION FOR EXPANSION. FIG. 10 CORRECTED LAYOUT TO ELIMINATE EXPANSION STRESSES. FIG. 11. COUPLING AND SHORT LENGTH OF PIPE USED TO MAKE UP DISCREPANCY CAUSED BY CUTTING PIPE TOO SHORT

feeding the factory is connected into the tee which keeps the engine steampipe clear of all condensation. As the steam in the factory is used for heating water, etc., the condensate does not go to waste as in the arrangement in Fig. 5. The drain below the tee leading into the factory is used only in case no steam is used in the factory for heating, but when it is necessary to run the engine.

Figure 7 shows the result of poor judgment on the part of another pipe fitter, who started to measure and cut pipe before making sure he would not run into some obstacle. In this instance it was necessary to run a 3-in. branch from a centrifugal pump which was located on one side of the building, to the opposite side of the building. Pipe A was cut and connected to the pump. In running the horizontal line B for

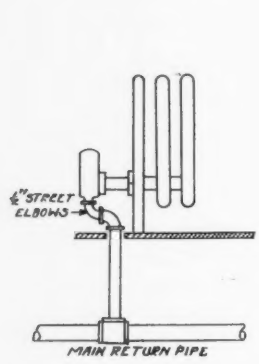


FIG. 12

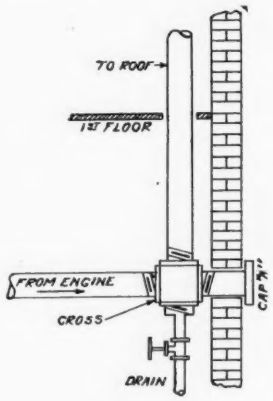


FIG. 13

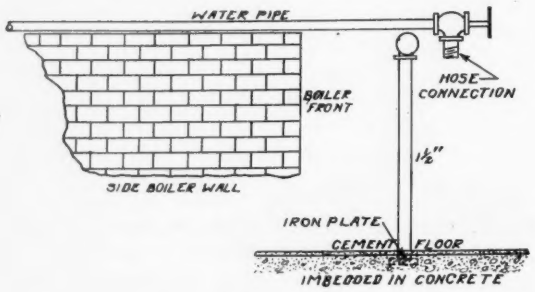


FIG. 14

FIG. 12. STREET ELLS USED TO REPLACE SHORT ELLS AND SHORT NIPPLES

FIG. 13. METHOD OF ANCHORING THE BASE OF A RISER

FIG. 14. GROUND SUPPORT FOR HORIZONTAL PIPE RUN

a short distance he found that he could not run the pipe in a straight line on account of the fact that another large pipe was in his way. To get out of the difficulty, the pipe had to be run as shown in Fig. 7. Had this man thoroughly looked over the grounds before commencing to measure and cut pipe he would have found that in order to have a clear run across the building, pipe A should have been a number of inches larger; also, in doing this, a number of turns in the line would have been avoided as shown in Fig. 8, besides the extra labor of cutting two nipples and the extra price of the elbows.

Poor Judgment of a Handyman

In many manufacturing plants they have what is called a handyman who is supposed to know a little of everything from running the power plant to scrubbing the office floor. One of these handymen caused much trouble in a plant where it was necessary to install a small steam engine to drive one department of the plant during the night. To make a quick job, he ran the steam pipe from the boilers directly to the engine as shown in Fig. 9, without making an allowance for expansion of the pipe. This placed a strain at the flange A, on top of the engine steam chest, making it necessary to renew the gasket between the flange frequently. To remedy this trouble, the piping was changed in that shown in Fig. 10. This allowed for expansion of the pipe, and there was no further trouble with a leaky flange. This experience shows that it pays in the long run to have an experienced man to lay out a piping job or do the work to avoid trouble later on.

Flanges Were Used to Prevent Further Trouble

A long line of 5-in. pipe was run from the boiler to an engine located some distance away. A few days after steam was turned into the line almost all the couplings started to leak. They were taken up by screwing the pipe into the coupling as far as was safe with a large chain tong. This stopped the leaks for only a short time. Then all the couplings were removed and flanges took their place, whereupon there was no further trouble.

In another instance where the wrong measurement was made for an extra heavy 6-in. pipe leading from the boiler to the engine, as shown in Fig. 11, Pipe A was cut too short and as there was no other pipe on hand which was long enough to take its place a coupling and short length of pipe was used to make up the discrepancy. Some time after the plant was in operation the coupling started to leak and screwing up on the joints helped matters for only a short time. Replacing the coupling by a flange ended the trouble.

I believe that in both of these instances the reason the couplings would not hold was because they would stretch to a certain extent when the joints were drawn up tight and as there is more or less shaking in a steam line to an engine caused by the opening and closing of the steam valves, etc., this would start the couplings to leak and in screwing up the coupling joints more the couplings would be stretched still more and therefore weakened.

As the flanges which were used were either of extra heavy cast iron or cast steel, there was little stretch in them when the joints were drawn up tight.

To Have Fewer Joints Use More Street Ells

While visiting a friend engineer, I noticed he had a large number of ½-in. close nipples and elbows lying on his work bench. Inquiring what they were to be used for, I was told that it was his intention to replace the traps on all radiator and steam coils in the plant by another make of radiator trap and to make the necessary turns and connections from the new traps into the same opening in the main return pipe a number of short nipples and ells were necessary as shown in Fig. 12. I advised him to use street ells in place of the

close nipples and ells, as he would eliminate two joints at each radiator trap, also less time and labor would be used to do the work and, best of all, less danger of having many leaks, after the work was completed.

A Few Kinks in Supporting Pipe Lines

At one time I found it necessary to run a 3-in. exhaust pipe along the inside of a brick wall up to the roof of a two-story brick building. It was necessary to anchor the pipe securely at the bottom where it turns up from the cross. As I had no material on hand to make a support that would hold and as the job was in a hurry, I supported the pipe as shown in Fig. 13, by placing a cross which I had on hand on the end of the horizontal pipe from the engine, then running a 3-in. nipple clear through the wall with a pipe cap on the outside of the wall as shown at A. This arrangement accomplished the desired result satisfactorily.

In another instance it was necessary to run a 2-in. water pipe from the water meter, which was located near the back end of the boilers, to the front end, to be used for cleaning purposes. At first I thought of running the pipe along the building wall of the boiler room near the ceiling. These walls were of cement block

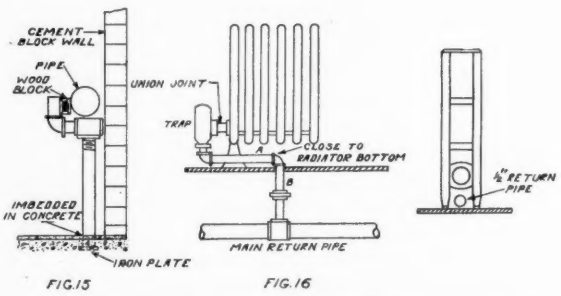


FIG. 15. METHOD OF KEEPING PIPE CLOSE TO WALL
FIG. 16. OFFSET RADIATOR RETURN CONNECTION

construction and one of the boiler side walls was close to it. Before beginning the work, I tried to find a way to anchor the pipe securely to the cement block wall by using either straps or hooks; but I found that it was not safe to attach a hook or pipe strap to this kind of wall. Perhaps poor material was used. Also there was one way of hanging the pipe from the ceiling without the expenditure of much labor and time.

I decided to lay the pipe on the side wall of the boiler next to the building wall, as shown in Fig. 14. As the pipe projected beyond the boiler front about 12 ft., a support was necessary to hold the pipe up against the building wall. One was made in the following way. A hole was cut in the cement floor, then a 1½-in. pipe was screwed into a tee, measurement was taken from the iron plate below the floor surface to the bottom of the pipe, and the pipe cut and placed as shown in Fig. 15. To keep the pipe close against the building wall, a close nipple and elbow was screwed into the tee, then another nipple into the elbow; between this nipple and pipe a block of wood was driven as shown, and the space between floor standpipe and iron plate filled with cement. After this was set, neither of the pipes could be moved.

Installing a Longer Radiator

At one time I had the job of installing a six-section longer radiator in an office room located on the second floor to replace another radiator which was too small. The longer radiator made it necessary to drill another hole through the floor for the ½-in. return pipe. The steam connection was to be left as it was. The owner, however, did not care to have another hole drilled in the floor and I was told that it would be preferable to run the pipe without making another hole.

In thinking the matter over, I decided to run the pipe through the old hole, as shown in Fig. 16. It will be noticed that the pipe runs partly under the radiator to meet the old hole. As it was impossible to connect the pipes under the radiator, Pipe A was cut first, then a close nipple and elbow was screwed into the traps and Pipe A and elbow into the elbow on the trap, then Pipe A was placed under the radiator and the trap connected to the radiator; next Pipe B was passed through the hole and screwed into the elbow and, connecting the union, completed the job. In this way I saved the time and labor in cutting a hole through the floor, also breaking into the main return pipe so as to bring the opening in line with the new hole.

Manufacture of Industrial Machinery, 1914 and 1919

Department of Commerce, Bureau of Census, has just issued a summary statement on the manufacture of industrial machinery for the years 1914 and 1919. Figures on some of the machinery more directly connected with power plants are given in the accompanying table, which shows the number of concerns engaged in the manufacture of each particular machine and the value of the products turned out during the year.

SUMMARY OF STATISTICS FOR THE MANUFACTURE OF POWER PLANT MACHINERY

	1919		1914	
Product	No. of firms	Value of Products	No. of firms	Value of Products
Air compressors	57	$13,960,000	84	$5,158,000
Blowers and fans....	43	9,498,000	..	.....
Condensers	16	9,387,000	..	.....
Cranes—				
Electric	33	25,865,000	..	.....
Steam and hydraulic	13	13,515,000	26	4,194,000
Other	38	9,568,000	..	.....
Elevators and elevator machinery...	195	54,052,000	213	17,228,000
Pumps and pumping machinery	204	65,360,000	298	27,457,000
Refrigerating machinery:				
Ice making	44	14,624,000	73	10,522,000
Other refrigerating	40	15,277,000	73	10,522,000
Steam shovels	8	9,654,000	..	.....
Stokers, mechanical..	9	2,811,000	..	.....

It is of interest to note that in nearly every case the number of concerns have decreased whereas the value of the products has increased in every case.

The Machinist-Engineer

EXPERIENCES ACQUIRED IN THE OLD TIME GENERAL MACHINE SHOP OF GREAT VALUE TO AN ENGINEER. BY BURTON ASHFORD

AN ENGINEER is an engineer regardless of the manner in which he obtained his knowledge. It makes little difference whether he has served a long machinist-apprenticeship, graduated from an engineering school, or worked himself up from the ranks of a fireman. "Delivering the goods" is the measure by which he gages success. There are many engineers today holding first-class and responsible positions at high salaries who began at the bottom and simply advanced by hard work, long hours and patient study.

In the making of engineers, the general machine shop deserves great credit. The writer learned how to do many things out of the ordinary there which came in

FIG. 1

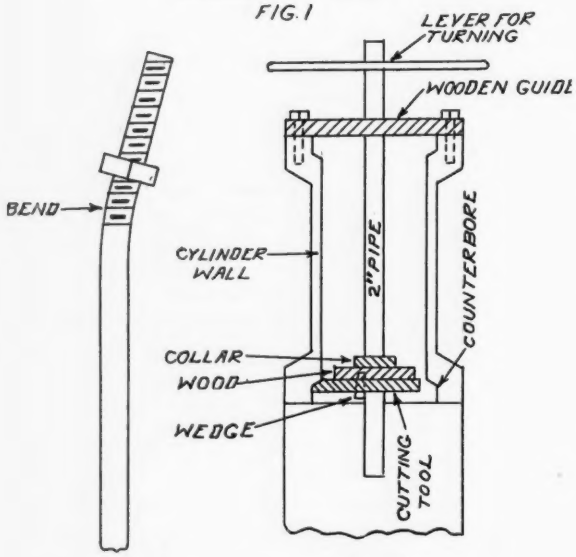


FIG. 2 FIG. 3

FIG. 1. METHOD OF MENDING BROKEN CRANKPIN
FIG. 2. BENT ECCENTRIC ROD
FIG. 3. IMPROVISED BORING MACHINE FOR CUTTING COUNTERBORE IN CYLINDER

to good advantage in positions held later on. The work in a small country machine shop may be anything from building small steam engines and running them to retubing boilers, tool dressing and setting up sawmills. They are called upon to do millwrighting, pipefitting, forge work and welding, babbiting and brass founding, armature repairing, and a host of other things too numerous to mention.

In the small country machine shop where the writer began his career hurry calls were often received to render first-air to injured or broken down machinery, plug up a leaking boiler tube, put on a soft or hard patch, etc. One day an engine broke its crankshaft at the pin. The crank ran nearly all the way across from the side of the web to the center of the pin, as shown in Fig. 1. The pin was about 2 in. in diameter. Without removing the shaft from its bearings we clamped the parts together and put in a ⅜-in. steel dowel pin, to keep the parts in perfect alinement and at the same time to add strength to the break. We then drilled a one-inch hole clean through the side pieces, pin and all, and slightly countersunk each end. A well-fitting steel pin, heated to a dull red, was quickly driven into the hole and riveted over before the metal cooled. The engine ran as well as ever after that and may be running yet.

Another time a pumping engine, left to run by itself, ran amuck, broke some of its parts and badly bent the valve gear. Again we were called upon to render first-aid. The cast-iron parts were all nicely patched together and wrought iron collars shrunk on, while the steel valve rods were heated in the forge and straightened out to run true between the lathe centers. This operation required considerable tact and good judgment on the part of the operator, together with the gentle prying with a steel lever on the tool rest and light tapping with a soft hammer. When the job was finished, the old pump ran as docile as ever. The knowledge gained by the repairs was of considerable value to the writer in later years when he had charge of a small isolated electric plant. One night the eccentric straps on a high speed engine ran hot and "froze" fast to the eccentric. Just before the engine came to a stop on the last turn-over the eccentric rod bent over several degrees in the thread back of the locknut against the strap, as shown in Fig. 2. The rod was certainly made of good material; it was tenacious, and held together well.

In this case, as there was no lathe or forge at hand, we had to resort to other means to straighten out the rod and get the engine back into service again. A pair of wooden cross arms were hastily bolted upright against the work bench, spaced approximately the right distance apart for the rod to swing between, with half-inch lag screws through the upper ends to form centers. The furnace answered very nicely for a forge. The rest was easy. With the locknut (cold) screwed up close to the beginning of the bend and caught in the vice, the red-hot rod was gently pulled over, at the same time tapping it lightly at the bend with a copper hammer. It was then screwed in a few threads and the operation repeated until the bend had been practically straightened out. It was heated again and swung between the centers for testing; a piece of chalk held against it marked the high spot. With a little more prying and hammering the job was soon completed and in an hour's time, the engine was running again, apparently as good as ever.

In the same plant, there was another high-speed engine which had been in daily use for a year or more when a peculiar knock began to develop in the cylinder at the crank end. Feeding more oil into the cylinder did not help matters any. The piston was equally spaced in the cylinder, and the rod was tight in the crosshead. Upon removing the cylinder head and piston, both the rings and spider were found to be intact but

upon examining the cylinder walls, we found a projecting ridge where the counterbore should be. In fact, there was but little if any counterbore at all. If the trouble had been at the head end, it would have been a simple matter to remove the ridge and file out a new counterbore, but it was at the crank end and difficult to get at. The cylinder was 12 in. in diameter. Early machine shop practice did me another good turn.

No boring bar being convenient with which to do the work, we rigged up a makeshift bar from material at hand. A piece of 2-in. black pipe about 4 ft. long and reduced on one end to fit the stuffing-box nicely answered for the bar. A short piece of two by six spruce plank with a suitable hole bored through for the pipe and bolted against the cylinder formed the rear guide. The bar itself had a ¾-in. square hole cut through about 6 in. back from the smaller end to hold the cutting tool, while the other end was bored with ¾-in. holes to receive a lever for turning purposes. An old square file ground down at the small end made an admirably fine cutting tool. The temper was drawn out for nearly its entire length, so that it could be wedged into the bar without fear of its breaking. A piece of two by four joist with a hole bored through for the bar was then slipped on against the tool to prevent its chattering while cutting. At first, the ridge was removed, which was simple. Then with a little practice and from time to time lengthening the tool a trifle a fairly good counterbore was put in. The chips, of course, were carefully removed through the drain cock when the boring was finished. The engine ran quietly after that. The reason was obvious.

Down in a dark pit about 20 ft. below the fireroom floor there were two duplex water service pumps drawing from a series of driven wells. The rocker arms, links, valve stems and piston rods were badly worn from long usage and lack of proper attention. The pumps ran in uneven jerks, steam hissed from the stuffing-boxes and water squirted out in icy jets. From practical experience gained beforehand, it was a simple matter to repair the pumps so that they ran without a whimper. One pump at a time was completely stripped of all its worn parts and gone over carefully. The piston rods were of Tobin bronze 1-15/16 in. in diameter, and were turned down true in an improvised lathe on the work bench. The stuffing-boxes were bushed with sheet brass, bent around a proper sized mandrel and then flared over on one end so as to form a small flange. After that the bushings were split in two with a hack saw, and both halves slipped on over the rod, when the pump was again assembled and ready for packing. Now that the rods were considerably smaller than before, a size larger packing had to be used on both the steam and the water end. The valve stems and link pins were trued up with a file. The links were reamed out a trifle larger and bushed with brass tubing. The reamers used in this case were made from chisel steel and tempered in oil. Old files, with the temper drawn out by heating to a dull red and then "soaked" for an hour or two in chimney soot or dry ashes, fashioned into reamers or drills by filling would have answered the purpose equally well.

On another occasion a broken cast-iron rocker arm on the boiler feed pump was quickly repaired by pinning the parts together lengthwise and brazing. After the parts were joined with a ⅜-in. steel pin, a fairly deep and wide groove was filed in the break all the way around and clean iron wire was wrapped around until the space was filled even with the rest. Extreme care has to be taken in the brazing of a job of this kind. With just the right heat to melt the spelter (common brass wire or gage glass rods will do) with a liberal amount of lump borax applied with a flat iron paddle, the metal will flow in between the iron wire, the crack and around the steel pin inside. The whole will unite into one complete part, ready for finishing off with the file after it has cooled sufficiently of its own accord.

Use of Pulverized Coal

Discussion Before the Prime Movers Committee of the N. E. L. A. By Frederick A. Scheffler

THE ATTITUDE of many pessimistic engineers has materially undergone a decided change during even the last few months, in regard to the adoption of pulverized coal for boiler furnaces. The subject is now considered to be of so much importance to the engineering fraternity that the Engineering Library Bureau in New York has compiled a bibliography covering the ten-year period between 1910 and 1920 and it consists of 280 references covering 44 pages.

There seems to be considerable misapprehension regarding the initial cost of an installation compared with that of stoker costs to serve the same amount of rated boiler capacity. This is primarily due to the fact that in considering the cost of an installation for pulverized coal all the equipment including track hopper, crusher, bucket elevators for raw coal and complete delivery system for the pulverized coal, as well as the driers and pulverizers and all motors, are included, as well as individual closed coal tanks for each boiler.

It is absolutely impossible to make any fair comparison of cost with stokers unless many additional items which the pulverized coal system replaces, are included.

Generally speaking, the cost will be more for a pulverized coal installation for a 3000 boiler hp. plant, about the same cost for a 4000 boiler hp. plant and less for a 5000 boiler hp. plant.

Every installation will have to be considered on its individual merit. Only facts and figures can determine whether stokers or pulverized coal should be used; but is it altogether a question of first cost?

It is the net results which you will all take into consideration and not the total first cost. Do not let that worry you when weighing total operating costs with pulverized coal, as these costs will show higher net efficiencies and bigger returns on the investment than any other improvement at present introduced in the best modern central station practice.

One of the latest designs of central stations is planned to produce a kilowatt-hour with 19,000 B.t.u. It is stated that the boiler, superheater and economizer efficiency will be 82 per cent.

It has been demonstrated that pulverized coal firing will give 88 to 89 per cent efficiency from boiler to economizer, when properly designed furnaces and equipment are used.

Let us see what this difference means in a 50,000 kw. plant operating on a basis of 45 per cent load factor.

As you are interested in only the "end figures" I will not burden you with the mathematics. Assuming $6 coal (net ton) and 12,000 B.t.u. per pound, the B.t.u. per kilowatt-hour will be 17,366 and saving annually will be $102,200. You can figure it out for yourselves how much additional investment that will provide, if it is necessary. I feel quite safe in saying that the principal companies installing apparatus of this kind will not hesitate to guarantee 82 per cent efficiency furnace, boiler and superheater (no economizer included) from any kind of bituminous coal as fired containing from 9500 to 14,000 B.t.u.

Every public service company is not so fortunate as to own its own coal mine and thus be sure of getting the same grade and quality of coal at all times. You can forget about where the coal comes from with pulverized coal and let your purchasing agent have a free hand to get you the most B.t.u. for the least money and also save your operating force a whole lot of worry because they will hardly know the difference in the operation of the boilers whether the coal contains 9500 or 14,000 B.t.u. and 30 per cent ash or 6 per cent.

Hunting Trouble in Mexico

MOSTLY TROUBLE HUNTS YOU; THERE'S NO NEED TO GO AFTER IT. BY JOHN PIERCE

HAVING decided to journey to the land of liberty —liberty to do as you please, and to be done by everybody—I accepted the offer of an engineering concern and started out merrily. The merriment shortly ceased. At El Paso I was held up for a passport. Trouble No. 1, and it took two weeks of telegraphing to mislaid relatives to prove that I had been born, was myself and was there. Then more delay getting the passport vised, with an extra charge of $10 for 10 seconds' work because it was a "holiday," and I crossed the river in a diseased Ford.

Inspecting is the best job the Mexican official does. The man who extricated my baggage from the flivver charged $1; three inspectors got $1 each for mussing up my wardrobe beyond replacement; inspectors collected several dollars for letting my bags go onto the train, besides duty on my box of much-used tools; and a couple more inspectors collected $1 each for pawing over my things during the 3-hr. delay before the train which was "all ready to go" got started.

We had a convoy train ahead, freight cars loaded inside, alongside and topside with soldiers and their families. I wondered what would happen to the swarm in case the train was attacked, but the legend is that the Mexican, soldier or bandit, shoots for the fun of the noise, not to hit anything.

At Saltillo we laid over for the night, and were warned to sleep with the windows down, no reason given. It was hot, so I left the window up about 4 in., putting my coat, money and watch under my head, and hanging my "panties" on a cord at my feet. In the night I felt a movement of the covers, and woke up to find them just disappearing through the window, my trousers having preceded them by means of a stick with a hook on the end. Fortunately I had another pair; but a portly gentleman in the next berth was not so fortunate, and went on to Mexico City in a bathrobe. He had lived for 30 yr. in Mexico and laughed about it, for he said "the Mexicans are a peculiar people, and I should have known better. All the poorer classes steal and beg, but among the better classes there are some who don't *beg*."

I have proved him wrong, however. All the poorer ones do beg, intensively and progressively. But among the better class they are sincere, earnest and honorable, good citizens, and put Americans to shame by their courtesy. They are delightfully honest and inclined to yield a point in business rather than drive a hard bargain.

Next day we went on to San Luis Potosi, from which I went to the plant which was my objective. Like most engineers coming to Mexico, I was prepared to tackle a bunch of dilapidated, out-of-date machinery. But I was surprised to find eight big Nordberg, compound, condensing engines in a row, working to capacity and without a sound or a jar. In trips made about the country since, I have found some of the finest modern machinery in the world. A lot of it is German and English, the former of massive construction and well built so that it will stand up for years under severe overloads.

I was now to take charge of the plant and, of course, a new man, like a new broom, thinks he can sweep very clean and make a lot of improvements. In justice to my predecessor, there was very little showing on the surface which would allow me to attain merit by effecting a remedy. All machinery was in fine shape and running beautifully. I found a few little things, and one or two big ones which were not from neglect but because the man before me had not been able to get time to make repairs; also he was not familiar with electrical matters, as he admitted. In another story, I shall tell some of the troubles and what I did to them.

Advice Befitting All

SPEAKING AT the commencement exercises of the Golden, Colo., School of Mines, Frederick Laist, general manager of the Anaconda Copper Mining Co., among other things gave advice as follows:

"Your future in the organization will depend on how well you accomplish each task that may be given you, however insignificant and unimportant it may seem to you at the moment. Your advancement will depend on how well you get on with your associates, and with men who may be working under you. You must cultivate a spirit of fairness, and a willingness to cooperate. You must treat the men under you with consideration and must recognize their fundamental rights. No matter how brilliant and able you may be, if you are a 'crab' and constantly fight with your associates or subordinates, you will get nowhere. Also, if when you reach a minor executive position, you endeavor to build up your own department at the expense of another department, you are not serving the best interests of the work as a whole and you will ultimately injure yourself. All managers realize that a certain amount of wholesome rivalry between departments is a fine thing. The rivalry must, however, be fair and must at all times take into consideration the general good."

As the writer sees it, Mr. Laist used an excellent method of pleading for, and explaining what the Golden Rule is. J. B. DILLON.

Balata and Fabric Belt Formulas and Chart

THE USE OF CHART SIMPLIFIES BELTING CALCULATIONS. BY W. F. SCHAPHORST*

THE writer has developed a formula for balata belts which is based on a well-known table as published by a prominent belt manufacturer. This is the formula:

$$W = \frac{H}{0.000{,}158\ N\ D\ (P-1)}$$

where W = width of belt in inches; H = horsepower to be transmitted; N = number of revolutions per minute; D = diameter of pulley in inches; P = number of plies.

This formula is usable for balata belts of 3, 4, 5, 6, 7, 8, 9 or 10 ply.

The accompanying chart will be found useful to buyers and users of balata belts in determining the horsepower that will be transmitted by any ply of belt 1 in. wide. It was designed from the above formula.

For example, how many horsepower will a balata belt of seven plies transmit when running 2000 ft. per min.?

Connect the 7 (column A) with the 2000 (column C) as shown by the dotted line and the intersection with column B gives the answer immediately as "a trifle over 7.2 hp." This is "for each inch of width." Thus a belt 10 in. wide would transmit 72 hp. when running 2000 ft. per min.

To show how the chart can be used "backwards" in solving problems that seem more complex, let us assume that you have an engine on which is a 4-ft. pulley, the face being 9 in. wide. The engine runs at a speed of 250 r.p.m. and develops 50 hp. How many plies should the balata belt contain?

First, to find the speed of the belt in feet per minute, multiply the diameter in feet by 3.1416 and then by the r.p.m. We therefore get $4 \times 3.1416 \times 250 = 3140$ ft. per min.

Next, it is customary to use belts on pulleys that are narrower than the pulley faces. This pulley being 9 in. wide, we would use an 8-in. belt. Each inch of width will therefore have to transmit $(50 \div 8)$ 6.25 hp.

Lastly, connect the 3140 (column C) with the 6.25 (column B) and the straightedge will intersect column A between the A and 5. Inasmuch as there is no such thing as a 4½-ply belt a 5-ply belt should be used.

FABRIC BELTS

THE RULES as ordinarily given for fabric belts made up in plies are somewhat like this: "A four-ply stitched canvas belt is equivalent to a single leather belt; eight-ply is equivalent to a double leather belt, and so forth."

Then, after knowing the equivalent we have to hunt up our rules of thumb for leather belts before being able to decide on a width necessary for a given drive.

These rules and equivalents have been studied and a formula devised that gives a direct answer without mentioning leather at all. The formula applies to most ordinary belts made up in plies such as rubber and stitched canvas.

The formula is:

$$\frac{W\ S}{\frac{2640}{P} + 136} = \text{Horsepower}$$

where W = width of belt in inches; S = speed of belt in feet per minute; P = number of plies; H = horsepower.

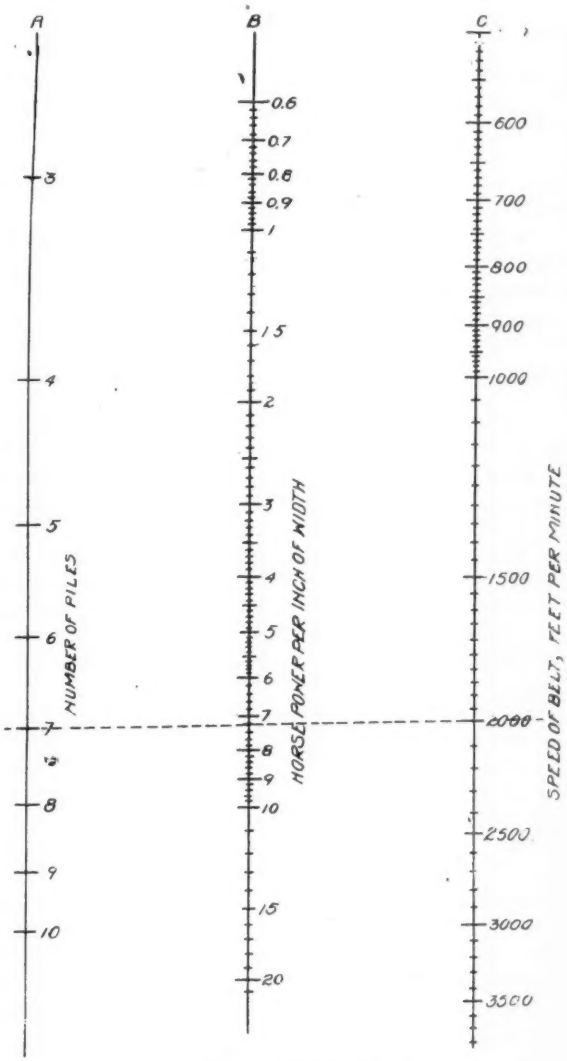


CHART FOR BALATA BELTS

For example, what horsepower may be transmitted by a 10-ply canvas belt whose width is 6 in. and whose speed is 4000 ft. per min.?

Substituting in the formula, we get:

$$\frac{6 \times 4000}{\frac{2640}{10} + 136} = 60 \text{ hp.}$$

*All rights reserved by the author.

Thrown into its other forms for the determination of either W, S or P, we have:

$$W = \frac{H}{S}\left[\frac{2640}{P} \times 136\right]; \quad S = \frac{H}{W}\left[\frac{2640}{P} \times 136\right]$$

$$P = \frac{2640}{\frac{W\,S}{H} - 136}$$

Sulphur Water Drains into Boiler Feed

By George C. Stierhoff

YEAR AFTER YEAR the plant of a large traction company had received the report that there was evidence of pitting in the drums of their boilers. This continued, and in a few years became quite serious. A report was then sent them that serious pitting had been found in the drums.

The matter was then taken up by the chief engineer, who ordered a thorough investigation to be made. This consisted of several tests, and the analysis of the feed water, which showed that there was sulphur in the boiler feed water. This sulphur was not present in the water before entering the plant, so it was then to be determined how the sulphur had gotten into the water.

This plant consisted of two rows of Babcock and Wilcox hand-fired boilers, ten boilers in each row. Below the floor between these boilers was built a feed water reservoir which received the exhaust, and condensate, and from which was pumped feed water to the boiler.

These boilers being hand-fired, it was necessary to clean the fires twice a day. When the red-hot coals were on the floor, they were quenched in the usual manner with water and the part of this water that had not gone off in the form of steam drained down into the boiler feed reservoir.

In doing this, the water soaked through the hot ash, and carried with it much sulphur, and, after repeated processes, the percentage of sulphur in the water had become serious. Water treatment processes or devices have little if any effect upon sulphur; so this went through the feed-water heater and treatment tank, thence to the boiler without being removed.

This had pitted practically the entire surface inside the drums of these boilers from ⅛ to nearly 3/16 in. deep, and had also been the cause of many leaky tubes.

After this discovery had been made, a new reservoir was built at a distant end of the plant where no drains could enter.

Superpower Zone Summary of Industrial Power and Fuel Consumption, 1919, has just been issued as a report by the Bureau of the Census in collaboration with the Superpower Survey. It defines the Superpower Zone, gives fuel statistics for manufacturing establishments and mines in this area. It shows the amount of power equipment by types and horsepower and gives the horsepower and amount of fuel consumed by industries.

Improving Lubrication

TESTS on the effect of mixing rape oil, fatty acids and oleic acid with Bayonne mineral oil, carried out at the National Physical Laboratory in England, were reported to the Department of Scientific and Industrial Research by J. H. Hyde. Results as given in Engineering of London showed that the straight Bayonne oil gave a coefficient of friction of 0.132; addition of one-tenth of 1 per cent of rape oil fatty acid reduced this to 0.92; adding 2 per cent of acid rape oil gave a value of 0.11; adding one-tenth of 1 per cent oleic acid gave a value of 0.108.

The best results came from addition of rape oil containing fatty acids, the 2 per cent (which gave an acidity of only 0.05 per cent) reducing the coefficient to 0.11. For an 8 per cent mixture (0.2 per cent acidity) the coefficient was 0.099; for a 20 per cent mixture (acidity 0.5 per cent) the value was 0.093; and for 40 per cent mixture (acidity 1 per cent) the value was 0.087. For rape oil alone (acidity 2.44 per cent) the value was 0.081.

The above tests were made on a machine specially designed by R. M. Deeley and seem to show that vegetable and animal oils are better than mineral for lubrication, friction alone being considered. Other tests made on a worm-gear testing machine showed efficiency of the gear with pure mineral oil 96 per cent; with a mixture of oleic acid to give acidity 0.2 per cent; efficiency was 96.4 per cent; and with mixture of acidity 2 per cent, efficiency was 96.6 per cent. Straight rape oil gave an efficiency of 96.7 per cent.

Correction Note

In connection with the series of articles entitled Methods of Recooling Condensing Water, appearing in the April 1, April 15 and May 1 numbers of Power Plant Engineering, our attention has been directed to several errors.

On page 409 (April 15 issue) in the first column, the author gives a formula for computing the temperature reduction effected by a spray nozzle installation. The last term in the numerator of this formula should have been raised to the fourth power, making it read

$$T_2 = T_1 - \frac{(T_1 + T_x + 920)^4 - 16\,(7_x + 460)^4}{16\,(K \times 10^8)}$$

Table I on page 409 (April 15 issue) giving spray nozzle capacities, gives the impression of applying to any type or make of nozzle. This is misleading, as the table refers only to nozzles manufactured by Schutte & Koerting Co. and should have been so designated.

In the paragraph classifying cooling towers on page 454 (May 1 issue), the author gives the impression that louvers are placed on a tower to increase cooling efficiency, whereas, as a matter of fact, they are placed on towers to keep the water from being blown out of the tower and actually decrease the cooling effect in most cases. The amount of such decrease depends upon the internal resistance of the tower.

The errors in the article were pointed out to us by The Cooling Tower Co., from whose catalog much of the data and formulas used in the article were taken and who also furnished the foregoing corrections.

Compound Feeder Based on Principles of the Pitot Tube

FIGURE 1 shows the means adopted by the writer for feeding boiler compound in a solid form (ball shape) to seven 500-hp. B. & W. boilers. This feeding device may be of interest to others, as it can be easily made in any plant from standard pipe fittings. Its operation is similar to that of many flow meters which depend for their operation upon the differential pressure action of a modified pitot tube.

The basic principle of operation for flow meters is illustrated in Fig. 2. S is the static opening and D the dynamic opening; U is an ordinary U-tube or manometer partially filled with mercury; when there is no flow, the surface of the mercury in column N and W will be on the same level; when there is a flow, the mercury will be depressed as indicated at H (Fig. 2) and the difference, H, will be a measure of the velocity of flow.

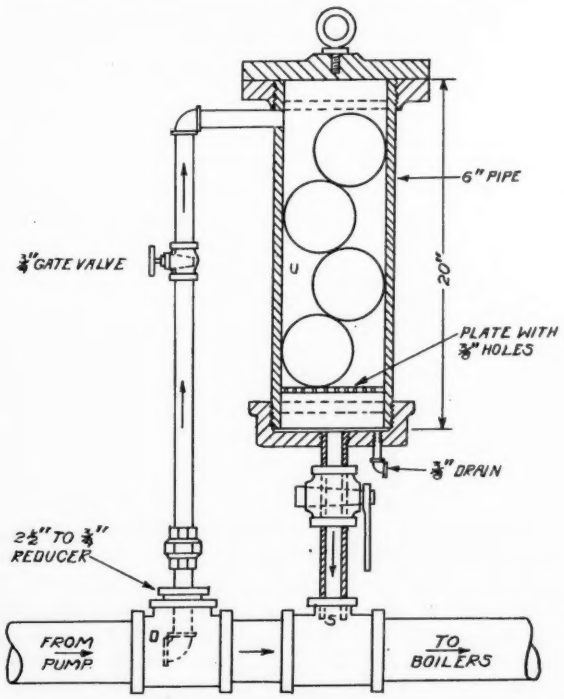


FIG. 1. COMPOUND FEEDER

The operation of the compound feeder shown in Fig. 1 is as follows: S is the static opening and D is the dynamic opening; U is a U-tube or manometer, one leg of which is made large enough to contain the balls of compound, and due to the absence of mercury in it which is approximately 13.6 times heavier than water, the water due to the differential pressure action is circulated from D, passing over the balls and slowly dissolving them, entering the main feed line again at S. The amount of water flowing over the balls in this way is proportional to the water flowing in the main feed line. The writer has been treating his feed water in this way for over a year with excellent results, and at the exceedingly low cost of 3.25 cents per 1000 gal.

A. E. REVILLUG.

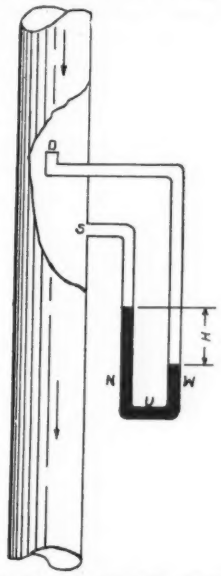


FIG. 2. PRINCIPLE OF THE FLOW METER

Setting Oil Fires

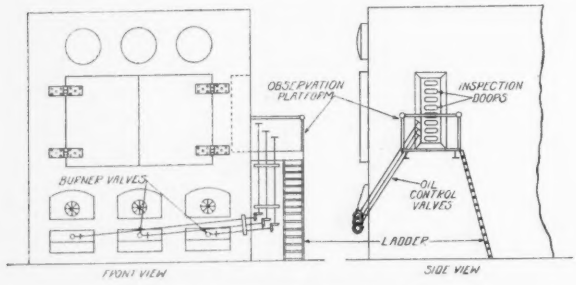
IN ORDER to obtain the best results in the utilization of oil as a fuel under boilers, it is necessary to so regulate the individual burner valves that the fires under the boiler are of uniform size. In other words, it is obviously undesirable to have one fire large and the remaining fires small, and vice versa.

In the modern oil-burning boiler plant, the fires under all boilers are regulated automatically by the increase or decrease in fuel oil pressure. As the pressure in the main steam header falls, the fuel oil pressure is increased, thus increasing the size of all fires proportionally. In the same manner, when the demand for steam falls off and the steam pressure rises, the fuel oil pressure is automatically decreased, which condition decreases the size of the individual fires under all boilers.

This automatic regulation, of necessity, affects all fires in the same degree, so that it is obvious that the

best regulation will result where all fires are the same size at the same time. In fact, smokeless combustion cannot result where one fire out of the lot is unduly high, so that when the steam pressure falls and the automatic regulator increases the oil pressure, this high fire will smoke. In this manner, one high fire will oftimes cause a smoky stack when if all fires were of equal size a clean stack would result. Again, if one fire out of the lot is abnormally low, an excess of cold air will pass at this point, thus unduly cooling the furnace gases. When the steam pressure increases and the oil pressure is cut down the low fire will puff out.

From the foregoing it is evident that every precaution should be taken to maintain all fires at a given setting. The accompanying illustration shows a method that has been adopted by a large concern and which has proven satisfactory. The experience of the operators at this plant has shown that the best position from which to judge the comparative sizes of the three fires under one of their boilers is through the side peepholes which are ordinarily used for blowing the soot off the tubes. In order conveniently and safely to inspect the fires from this point, they have erected light steel platforms on the side of each boiler and each platform is surrounded by a safety rail, with a ladder leading to it.



ARRANGEMENT USED FOR SETTING OIL FIRES

The point where the inspection is made is between the third and fourth rows of tubes up and in the first pass. At this point, one can readily tell whether the three fires are all the same size or not.

In order to control the individual fires from the point of observation, the control valve on each burner is connected through a set of mitre gears to extension handles at the observation platform. With the control thus arranged, it is a simple matter to go over all of the boilers the first thing after coming on shift and set them at the proper point. With clean, hot oil, one setting is usually sufficient for the 8-hr. shift.

CLAUDE BROWN.

Running Part Condensing

IN THE April 1 issue, Mr. Cultra in describing his system of heating the building by running one end of his engine with only 10 in. of vacuum (page 390, second column) while the opposite end has by the card 25 in. vacuum, states that because of 10 in. vacuum it would be necessary to increase the cutoff on this 10-in. vacuum end, which does not appeal to me as the way to balance up this engine. I think there would be some main belt slapping if he should balance the engine this way, as a matter of fact, the end that shows 25 in. vacuum on its card is doing the least work because this 25 in. does not act on the end that it is attached to, but the opposite end, which shows only 10 in. heating the building, so the engine would be badly mixed up if his advice was followed by V. K. N.

To illustrate this mix-up, I have plotted three cards which are not drawn to scale, but simply to illustrate the method of procedure in crediting each vacuum to the side it is assisting. Figure 1, I think, fairly illustrates his part condensing scheme; the crank end shows only 10 in. vacuum and so, of course, he means that this is heating the building, and because of 10 in. vacuum he advises to lengthen the cutoff when, as a matter of fact, this same end is getting the entire benefit of the 25 in. vacuum on the opposite end.

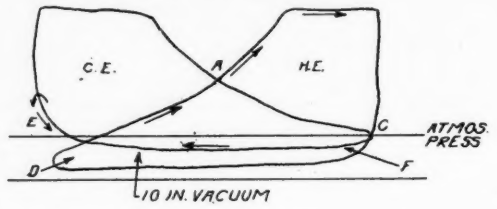


FIG. 1

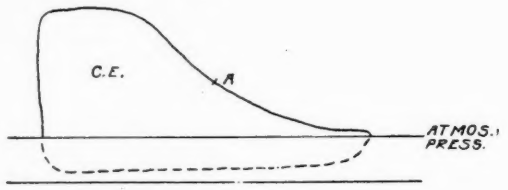


FIG 2

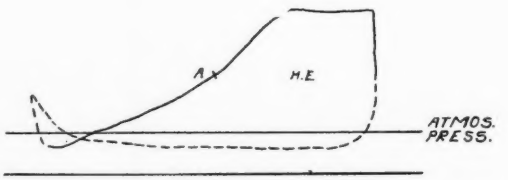


FIG. 3

FIG. 1. TYPICAL DIAGRAM FROM ENGINE RUNNING WITH DIFFERENT EXHAUST PRESSURES ON THE ENDS OF THE CYLINDER
FIG. 2. REVISED CRANK END CARD
FIG. 3. REVISED HEAD END CARD

Hence it is plain that the head end that is not heating the building and cutoff on the end of the cylinder whose card shows 25 in. vacuum is the one that should be lengthened because it has only 10 in. vacuum on its opposite or crank end that is assisting it. To illustrate further, in figuring the cards from a part condensing engine, start at A on head end card, trace to right to C, then along back pressure line of crank end card F, at E drop down across the compression space between compression curve of crank end expansion line of head end and go up expansion line to A again. Next take the crand end card, start at A and when you get to C, then drop down the compression line and back pressure line to head end card and go to D, then up to E, continue up to crank end admission and around to A again. The best way is to reproduce such cards on transparent paper separated, then place one above the other with the

transparent paper between, having atmospheric lines together. You can then go over the cards and bring them out like Figs. 2 and 3 which will show the true state of affairs and why the end heating the building is doing more than the head end already because a condenser does not pull the end it is hitched to only indirectly. A. C. WALDRON.

(Mr. Waldron states: "The end that shows 25 in. vacuum is doing the least work." As a matter of fact, more heat units are converted into mechanical energy from each pound of steam entering this end of the cylinder than from that entering the other end. It is evident, however, that the effective pressure acting to drive the piston from the head end to the crank end is less than during the return stroke and to make the effective pressures during the forward and return strokes equal, the adjustment advised by Mr. Waldron would be necessary. Engines intended for this service, however, should be provided with a sufficiently heavy flywheel to even up the pull on the belt and thus prevent the flapping mentioned.—EDITOR.)

Purging Air from Ammonia System

REFERRING to the article on page 627 of the June 15 issue of Power Plant Engineering, under the caption, Purging Air out of Ammonia System: In purging the absorber of an absorption machine, I obtain good results purging just above the liquor line.

An ammonia condenser, I purge from the top, but use a still by means of which I can save considerable ammonia either from purging or from draining oil out of the system.

In the accompanying illustration, A is an iron tank 3 ft. 6 in. high by 1 ft. 4 in. in diameter, B is a purge line from the top of the condenser, C is an oil line from the ammonia separator, D is an oil line from the receiver, E is a drain line, J connects to the compressor suction and G is a vent line. Fill tank A half full of water and then partly open valve B to allow the foul gases from the condenser to blow through the water, which will absorb the ammonia present in the gases and allow the air to pass out through valve G into a bucket H filled with water. When ammonia fumes are noticeable at H, close valves G and B. The volume of the water in the tank will be greater due to the absorption of ammonia gas and its temperature will be increased. Now open valve F to the compressor and apply steam to the tank, either through a steam coil inside the tank or through a jet. Heat the liquor to about 150 deg. F and the ammonia gas will be distilled off and will pass to the compressor. When the liquid level has returned nearly to its original position, turn off the steam jet, close valve F and allow the weak liquor to cool. If the air is not all out of the system, the process may be repeated, otherwise drain the tank through drain E. This water contains a small percentage of ammonia and can well be used for cleaning purposes.

To drain the oil from the separator or receiver open either valve C or D and also valve F. Oil will accumulate in A and the tank will be frosted on the outside up to the oil level. Heat the oil to about 110 deg. F., then allow it to cool, closing valve F. The oil can then be drained off through E without a loss of ammonia.

When I took charge of my present plant, I fitted up this still and recovered enough oil to operate the compressor for a year. The compressor is an 80-ton

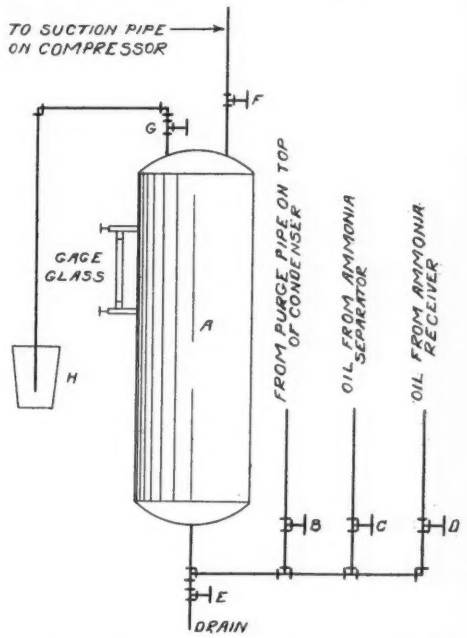


DIAGRAM OF DISTILLING APPARATUS USED TO PURGE AMMONIA SYSTEM

machine which runs 24 hr. a day and most of the time 7 days a week. R. B. ROWE.

Attributes of the Successful Engineer

ACCURACY and conscientious loyalty are two of the most necessary qualities which a young engineer should possess if he is to succeed. There are many engineers whose skill would permit them to hold more responsible positions were it not for the fact that their work is known to be slovenly and slipshod. Others have entered the class of failures simply because they do not understand the meaning and practice of the word loyalty.

The following story is a good illustration of this class of engineer: A certain power plant engineer who really possessed ability obtained a position as the chief of a large power plant which had been neglected for some time. There were leaky valves, corroded and scale covered boilers and everywhere could be seen signs of waste and inefficiency.

The engineer determined to make a record for himself so he went through the plant from end to end and fixed up everything in sight. He soon had the plant in first-class shape. Charts showed high efficiency of operation, fuel costs were cut considerably and his efforts were rewarded by a substantial increase in salary.

Now comes the point which this article is intended to emphasize. The engineer kept up the good work for a few months and then his interest flagged. He wasn't quite so keen about searching for leaks and remedying trouble and the result was that a few months later the charts and curves showed that the efficiency had dropped considerably and fuel expenses had jumped up accordingly. To make a long story short, he was finally fired.

Now the moral of the foregoing tale is this: If you set a standard, maintain it. Don't get the idea into your head that you can bring the plant up to a certain standard of operation and then rest on your laurels for the rest of your life. The engineer is paid to get results and every good engineer does get results.

To one thing the young engineer can make up his mind and that is, that if he really wants to succeed he has got to cultivate the habit of absolute accuracy and loyalty. Make sure that you are right and then go ahead. Do your best at all times and the reward will come.

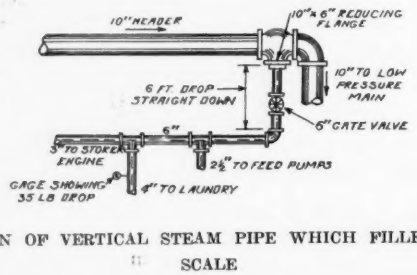
Loyalty is another attribute of success. If you don't like your boss or the firm, get out and look for another position; but don't knock the company—at least while you are taking their pay. Remember that if you run the company down you will not only get the name of "knocker," but, as a matter of fact, you will and should be considered just as bad as the firm because "a man is judged by the company he keeps."

C. R. TIGHE.

Scale in Steam Line

AFTER reading a letter in the June 15 issue relative to scale, compound, etc., in steam lines, I must tell about some grief I just had and found after some sleepless nights.

I work at a central station live-steam heating plant, where we sell only low-pressure steam for heating, and supply a laundry about 1500 ft. away with boiler pressure (125 lb.) through a 4-in. line, with an ordinary drop in pressure of 5 to 15 lb. We started receiving complaints about the pressure being down and by checking up I found that the drop was about 35 lb. under ordinary load and as high as 50 lb. on peak.



LOCATION OF VERTICAL STEAM PIPE WHICH FILLED WITH SCALE

I started back from laundry with test gage and worked back to within 20 ft. of the 6 by 3 by 4-in. tee and assumed stoppage was in the tee so I came back to work in the wee hours and tore into it and found nothing, so I decided it must be in 10 by 6-in. reducing flange, so we took out the piece of pipe between header and gate valve and found that the 6-in. pipe from 1 ft. above to 1 ft. below the valve was so full of scale that there was hardly the area of a 1½-in. pipe left open. We had it analyzed and found it was boiler scale. We had not been troubled with any noticeable foaming, and the 6-in. valve had been operated often enough that it was quite clear.

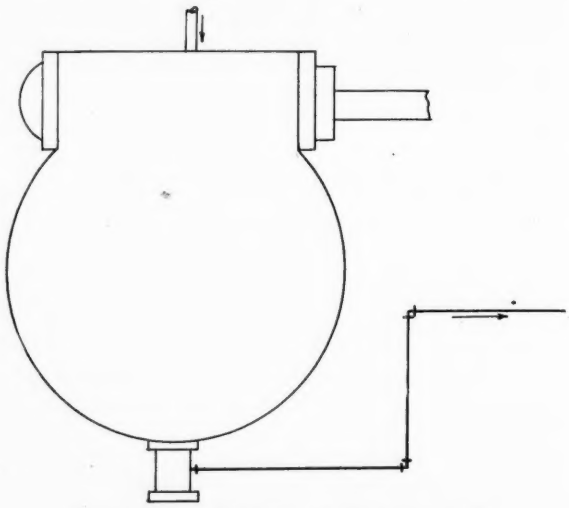
What seems queer to me is that it stopped in a straight vertical line and the reducing fittings were clear. The accompanying sketch will give an idea of the layout.

E. G. KNAPP.

Insuring Oil for Worm Gear Casing

WE HAD in service a worm and gear drive on our conveyor system in the boiler room, and after service of only about a year we found that the worm had entirely worn so that it required replacement. Investigation developed that during the period it was in service it was frequently overlooked as regards securing attention in the way of oiling; in other words, the attendants did not clean the oil out at intervals and supply fresh clean oil.

Because of the location of the drive, it was apparent that it would be difficult to secure regular attention for it, so we conceived the idea of connecting this drive into our regular oiling system so that it would be automatically supplied. To do this, we brought an oil line



METHOD OF SUPPLYING OIL TO WORM GEAR

connection to the top of the casing, and to the catch pocket at the base we connected the used oil line which lead to the oil filter, taking care to arrange this piping with a seal so that a level of oil about 6 in. high would be maintained in the casing in order that the gear would have ample opportunity to pick up sufficient oil for the worm. This arrangement assured the drive of a constant supply of oil, and with the occasional cleaning out of the drip pocket enabled us to keep the worm and gear in excellent working condition.

M. A. SALLER.

Consider These Cards from Old Engines

HERE IS the case that tests the validity of the rule. According to all the "dope," the engine from which the card shown in Fig. 1 was taken should have been scrapped years ago. Look at the card which was submitted by H. W. Woodstock. It is practically ideal. This engine, an 18 by 48-in. with Corliss valve gear, has been in service for 39 yr. and is still handling a 550 amp., 225-v. load with 95 lb. steam pressure and is regularly making its 68 revolutions every minute. What with depreciation, amortization, and obsolescence charges in vogue when this installation was made, this engine could have been entirely written off the books nearly 20 yr. ago. The work that it is putting out now can be considered done at the cost of steam, maintenance and

attendance. No fixed charges except rental of the space it occupies need be charged against it.

The card shown in Fig. 2 which was submitted by C. A. Rosa, was taken from an 18 by 36-in. double eccentric Corliss engine. This machine has been in constant operation since 1904 and is still delivering the goods. It is claimed that during this time only $38.75 has been spent on repairs exclusive of packing. This represents an annual repair bill of $2.28. This engine

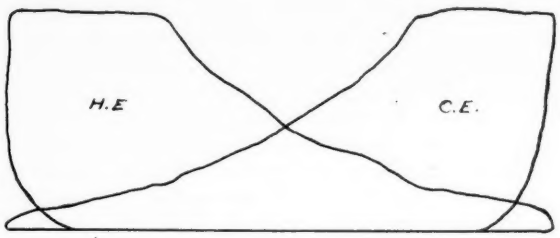


FIG. 1

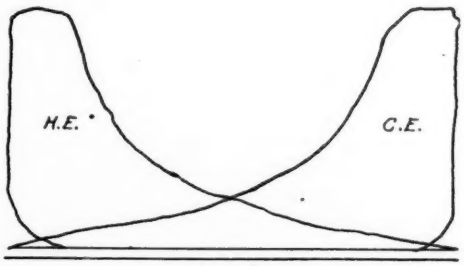


FIG. 2

FIG. 1. INDICATOR DIAGRAM FROM A C. H. BROWN 18 BY 48-IN. ENGINE

FIG. 2. CARD TAKEN FROM A DOUBLE ECCENTRIC 18 BY 36-IN. OHIO CORLISS

takes steam at 120 lb. exhausts against a back pressure of 3 lb. and carries a load of 900 amp. at 115 v. It will be noted that the expansion curves of this card are almost exactly coincident with the hypothetical line and that the card in other respects approximates the ideal.

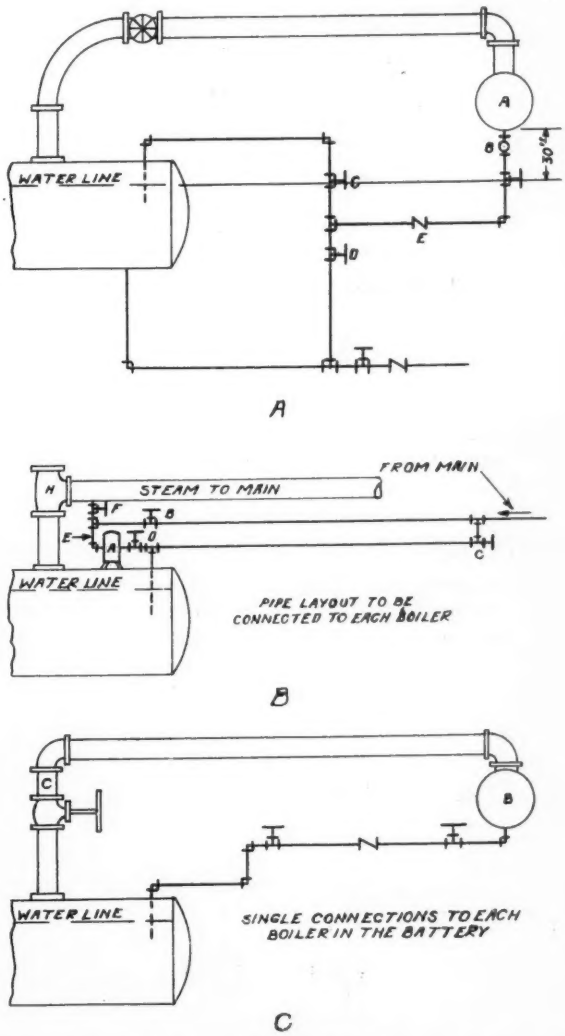
Returning Condensate to Boilers

INFORMATION is sometimes desired in reference to draining the condensate in mains into the boilers under pressure. The sketches with this article show several safe and satisfactory methods for doing this. Frequently drain pipes are installed with the discharge end in the steam space. This is not the best practice. In all such drains the ends should extend to below the water level in the boiler and the bottom of the pipe to be drained should be at least 30 in. higher than the water level. The pressure in the boiler and in the main being equal, the condensate will return by gravity even if the bottom of the main is less than this height, as it often happens. Under certain conditions the pressure in the mains is slightly lower than that in the boiler. It is good policy to use as high a drip as possible to ensure a properly operating drip.

In sketch A the tee B is to be used to connect from other boilers in a battery. Each boiler will require a set of pipe connections as shown, the discharge being into the circulating pipe. All the valves shown in the sketches are not required in actual operation, but if they are used certain repairs can be made without interrupting operation, which otherwise would be impossible.

Sketch B is a method used to drain a long pipe between the main pipe and the valve when the boiler is out of service, A being a trap. It is obvious this drain could empty into a hot well, heater, sewer, or otherwise; but I am trying to explain methods used for draining into boilers.

Sketch C shows the main pipe drained, but not the connecting pipe as in Sketch B. With the boiler valve closed and steam from other boilers on the main B, the



THREE SYSTEMS OF DRIP PIPING FOR RETURNING CONDENSATE TO BOILERS

upright pipe C will soon fill with condensate. With careless handling of the valve when cutting in the boiler, such entrapped water could do considerable damage by water hammer. In Sketch B, when the boiler is in use, valve D is closed and valve C is open. Some engineers place valve F at E.

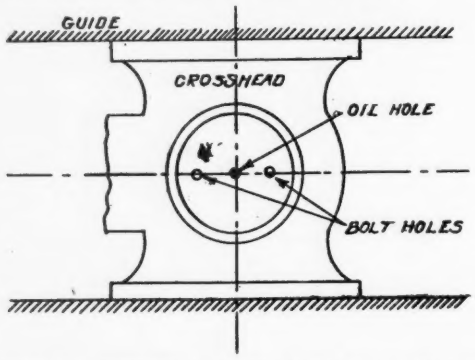
JAMES E. NOBLE.

Emergency Lubricating Device

WHAT TO DO was the question when the oscillating oil feed between the engine frame and the crosshead of the 16 by 42-in. Atlas-Corliss engine wrung off at both ends.

We had not time to have the brass oiling piece on the crosshead welded, as we had to get back on the line in an hour.

The writer and the engineer rigged up the following makeshift: We removed the brass piece still remaining on the crosshead and cut a rubber gasket to fit in its place, making holes for the two screws and oil hole running to the center of the crosshead. We then got a 4 by 4 by 4-in. tin elevator bucket and drilled three holes in it to correspond to the oil hole and the screw holes in the crosshead. The bucket was filled with oil.



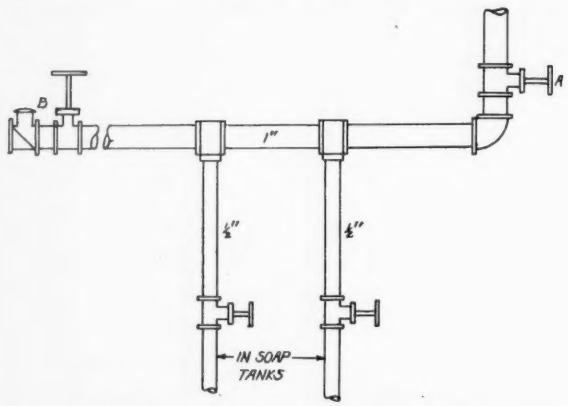
VIEW OF CROSSHEAD AFTER OILER WAS REMOVED

This makeshift was entirely satisfactory, as the rubber gasket prevented leakage, and although the cup was filled with oil, there was no tendency to splash.

J. B. FICKLEN, III.

Preventing Soapsuds from Entering Steam Pipes

IN A LARGE steam laundry where a number of steel tanks are in use for boiling soap with steam, the steam pipe leading to these tanks is arranged as shown in the



SKETCH SHOWING LOCATION OF CHECK VALVE TO PREVENT FORMATION OF VACUUM

illustration. A 1-in. main runs above the tanks; from this main ½-in. branches lead to each tank. Formerly much trouble was experienced due to the soap solution being drawn into the branch pipes and main steam line during the night when the steam was shut off on the line. The solution would become hard in the pipes after they cooled and the starting of the plant was delayed the next morning until the pipes could be cleared again.

The trouble was caused in the following way. Each night the steam is shut off on the main line by valve A. As the pressure in the line would lower gradually, it would cause a vacuum to be formed in the pipe and if any of the valves leaked in the ½-in. branches leading into the tanks, some of the soap solution would be drawn into the ½-in. pipes and the 1-in. main. To remedy this trouble, a ⅜-in. swing check valve was placed at the end of the steam main as shown at B. After this there was no further trouble, as the check valve would open as soon as the pressure was reduced and the forming of a vacuum in the pipe. A globe valve was placed next to the check valve, since in case this check valve should leak badly at time, the globe valve can be closed and repairs made.

H. A. JAHNKE.

How to Put Gaskets on Boiler Manheads

IN THE July 1 issue, page 670, H. A. Jahnke tells how to put gaskets on boiler handheads.

I will tell you a better way. You don't want a gasket to come off the manhead every time you take the head off. Clean off the manhead and don't put any graphite on the manhead, then the gasket will stay on the manhead as it should. If you want to use it again, put graphite on the side of the gasket that comes in contact with the boiler, put the manhead in place and tighten it up, then make three marks on the manhead and on the boiler also, in line with each other. Now when you remove the manhead for any purpose, always put it in its place so your marks on the manhead and on the boiler are in line with each other, and there will be no trouble about leaks.

GEO. LIESER.

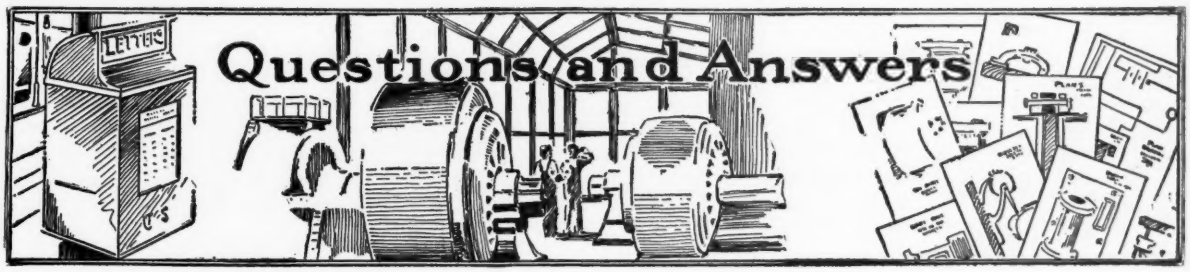
Power Plant Records Worthy of Note

THE WRITER, in a recent article, narrated that the Denver Gas and Electric company gave excellent electrical service to its patrons, and also told how the current was obtained from the Colorado Power Co.

In the hearing for an advanced rate by the Colorado Power Co., it was brought out that the Denver company had failed to give good service for only two days out of 5 yr., and the Colorado Power Co. had failed only 85 days in 5 yr. to give the Denver Co. the power it paid for and when it is considered that the Colorado company's power must come over the mountains regardless of weather conditions, the merit will be patent.

J. B. DILLON.

TUBERCULOSIS patients in U. S. Public Health Hospitals will soon be able to view a cinema film of one reel that shows the effects of sun treatment on bone and gland tuberculosis, as exemplified at the J. N. Adam Memorial Hospital, Perryburg, N. Y. It is believed that the showing will encourage the patients to stick to the rigorous outdoor treatment necessary for cure. The film will be taken to each tuberculosis hospital in turn.



Engine and Boiler Room Questions

IF THE dashpot of a Corliss engine was not closing the valve quickly, what effect would it have on the operation of the engine?

2. How would you give a slide valve more lead if you did not wish to change any other function of the valve?

3. If the spring in a flywheel shaft governor should break or become loosened, how would it affect the running of the engine?

4. Why would there be a lack of economy in the operation of an engine having more cylinder clearance than necessary?

5. When setting the steam valve of an engine should the jamb nuts be drawn up tight against the valve lug? Give reason.

6. What advantages are to be had by the use of mechanical stokers as compared with hand-fired operation?

7. What is the advantage of keeping the fuel bed thicker back towards the bridge wall than it is on the front part of the grates?

8. What will be the total pressure against the disc of a 3-in. safety valve when steam pressure is 120 lb. per sq. in.?

9. Neglecting the loss by friction, etc., to what height will water be elevated by a pressure of 125 lb. per sq. in.?

10. Tell how to install a sight feed lubricator for cylinder lubrication? W. E. G.

Cause of Bowed Boiler Stay

I BELIEVE that the cause of a bowed or sagged head-to-head boiler stay, about which A. C. W. asks on page 682 of the July 1 issue, is the bending or buckling of the tubes due to boiler scale.

In a return tubular boiler the scale deposits principally on the top and outside wall of the tube and causes overheating and stretching of the tube. The tube either loosens in the header or, if it is well rolled, the stretching causes the tube to buckle or bend downward, as the upper wall of the tube is held in a vise-like grip by the scale deposit.

If this buckling takes place on a sufficient number of tubes, the strain is sufficient to buckle or warp the header inward and of course the boiler stay will buckle as a result.

This bending of the tubes is also very common in water-tube boilers, especially in the two bottom rows, but in that type of boiler the bending is always upward, due to the scale depositing principally on the bottom wall of the tube, thus holding the bottom wall rigid and creating an upward bend along the lines of least resistance. LEO SHIRE.

Feed Water Heater

WILL YOU kindly help me solve a feed-water heater problem?

The accompanying sketch shows the heater as at present connected. We are getting considerable oil over into the boilers, so I am going to remove valve No. 2 marked on sketch or put in its place a 10-in. oil separator. A small amount of steam is continuously going out to the atmosphere, although our feed-water temperature only averages about 150 deg. or slightly less. When extra steam-driven exciter units, air compressors or pumps are running the feed temperature sometimes goes as high as 180 or 190 deg.

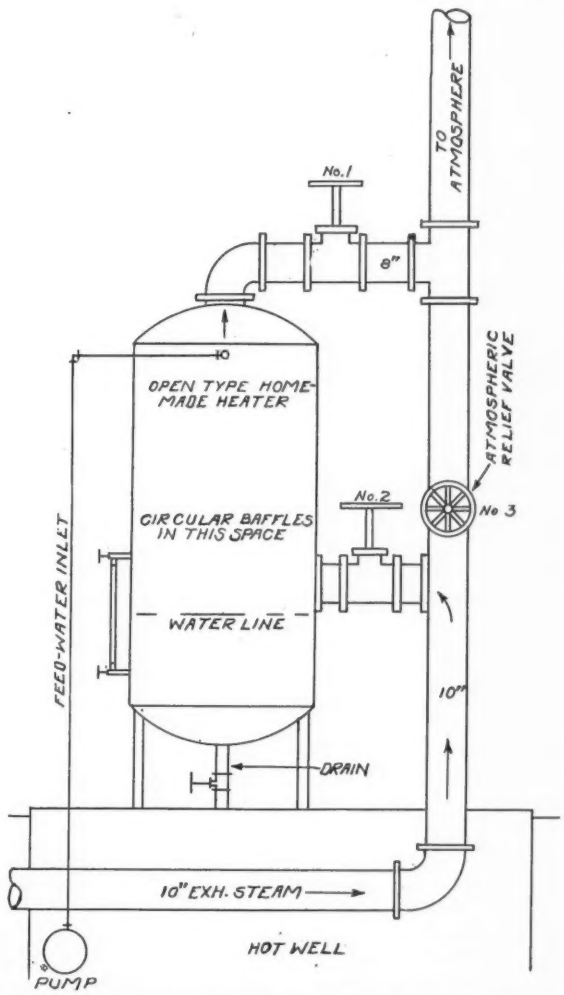


DIAGRAM OF PROPOSED FEED-WATER HEATER CONNECTIONS

My idea was to install a back-pressure valve between valve No. 1 and the atmospheric line, and operate the heater with about 2 or 3 lb. back pressure.

Do you think my plan practical, from an operating standpoint?

Is the location of the back-pressure valve correct?

Will the operation of pumps and small steam-driven units be affected any by this back pressure on the heater and exhaust line?

Valve No. 3 is permanently closed. This heater originally was of the closed type but was unsatisfactory, and was therefore changed into an open type. A. C. B.

Ohm's Law

COMMENTING ON the answers to "Miscellaneous Questions on Electricity" on page 634 of the June 15 issue, I would suggest that, as the ampere, ohm, and volt are always encountered in the very beginning of the study of electricity, and as the student is unfamiliar with the terms, any definition of the one, making use of either of the others, will come far short of clearing up in the beginner's mind, the real meaning of these elementary electrical terms.

True enough, "A volt may be defined as the electromotive force required to cause a flow of one ampere through a resistance of one ohm, but the next question is: What is electromotive force? Now this will be understood if its three parts are considered separately as: electro, which means resulting from, or pertaining to electricity; motive, meaning to move or to have a tendency to move; and force, which is that which tends to produce, destroy, or change the direction of motion. Then to sum up: Electromotive force is that force which tends to produce motion in electricity. This is analogous to pressure in hydraulics. To be able to compare different pressures, in hydraulics, or even to conceive, of the magnitude of any pressure under consideration, it is necessary to have a unit, whose value is generally accepted. This unit of hydraulics, is the pound. In electricity, electromotive force, or that which tends to produce electrical motion, is electrical pressure, and to be able to conceive of its magnitude it is as necessary, as it was in hydraulics, to have a unit with a generally accepted value, by which it may be measured. This unit is the volt, which name was given in honor of Allessandro Volta, in recognition of the work he did in establishing some of the fundamental facts in the early stages of the study of electricity.

In the flow of electricity, we are particularly interested in the rate of flow, that is, what quantity of electricity will pass a certain point in a given time? In hydraulics, a similar rate of flow would be expressed as a certain number of gallons per second. In electricity, this rate of flow is expressed in amperes.

When motion is produced, it always meets with resistance. This resistance to the flow of electricity is an inherent property of the substance of which the electric conductor is composed. With a conductor of any given substance, the resistance will vary as the length, and inversely as the cross section of the conductor. The unit by which this resistance is measured, is called the ohm, in honor of Prof. Ohm, who discovered the relation between the three fundamental units just defined.

This relation, or law, is known as "Ohm's Law," and briefly stated is: "The current in amperes is equal to the electromotive force in volts divided by the resistance in ohms." J. M. Row.

Editor's note: It is true that in this question the volt is defined in terms of amperes and ohms; but is this not permissible when the ampere and ohm are defined independently of the volt as they are in questions 2 and 3?

Testing for Polarity of D. C. Circuit

IN THE ANSWER to question 15 under the caption "Miscellaneous Electrical Question" on page 685 of the July 1 issue, it is stated that to test for polarity in a d.c. current, dip the leads into a salt solution and bubbles of gas will be given off in greater quantity at the negative pole.

There is another method we often resort to in the mine when glass and salt water may not be at hand. All that is required is a lamp socket, a bulb and sufficient insulated wire to reach from the lead wire to the rail on any damp ground. Have one side of socket connected to the current wire and the other side to ground. The positive connection will show a glow in the bulb and if a good ground is made, a fairly good light will result. The negative, of course, will not.

S. W. PHILLIPS.

Surface Condenser Operation

I WOULD like to know how to determine the amount of condensing water required and also whether the vacuum is as high as it should be on a surface condenser operating under the following conditions:

Barometer, in mercury	29.39@67 deg.
Steam condensed per hr., lb.	365,000
Vacuum at condenser, in mercury	27.76@80 deg.
Temp. of exhaust steam, deg. F.	98
Condenser water inlet, deg. F.	60
Condenser water outlet, deg. F.	71.5
Temp. of condensate in hotwell, deg. F.	89
Condenser surface, sq. ft.	50,000

C. H. McK.

A. In determining the performance of a surface condenser, we have the relation that the heat given up by the steam is equal to that absorbed by the cooling water which is also equal to that passing through the condenser tubes, neglecting radiation losses.

The heat transferred to the condenser in B.t.u. per hr. is equal to $w(H - t + 32)$ where w is the pounds of steam condensed per hour. H is the total heat in the steam at condenser pressure or exhaust steam temperature and t is the temperature of the condensate or hotwell.

The heat absorbed by the water is equal to $q(t_2 - t_1)$ where q is the pounds of circulating water per hour and t_2 and t_1 are the final and initial temperatures of the circulating water.

Equating these two expressions we find that

$$q = w \times (H - t + 32) \div (t_2 - t_1)$$

It should be noted here that the condenser vacuum and the temperature of the exhaust steam do not agree and the difference will introduce a slight error in finding the cooling water required.

We will take an average of the total heat values corresponding to the vacuum and steam temperature readings. The total heat of the steam, H, at temperature of 98 deg. F. is, from the steam tables, 1102.9.

The vacuum, 27.76 in. mercury at 80 deg. F. corrected to 32 deg. by the correction factor is

$$h = 27.76\ [1 - 0.000{,}101\ (80 - 32)\ ] = 27.62 \text{ in.}$$

The corrected barometer reading is, in the same way, 29.27 in. The absolute pressure is then $29.27 - 27.62 = 1.65$ in. of mercury, which is equal to $1.65 \div 2.03 = 0.812$ lb. per sq. in. abs. The total heat, H, corresponding with this pressure is 1101.4. Averaging these two figures 1102.9 and 1101.4 we get $H = 1102.1$.

Substituting the values you have given in the expression for q we obtain:

$$q = 365{,}000\ (1102.1 - 89 + 32) \div (71.5 - 60)$$
$$= 365{,}000 \times 90.87 = 33{,}167{,}550 \text{ lb. per hr.}$$

These figures indicate that the ratio of cooling water to condensate is 90.94 to 1 which we think is rather high for the vacuum carried.

The heat transmitted through the condenser tubes is equal to A U d, where A is the extent of condenser surface in square feet, U is the coefficient of heat transmission in B.t.u. per sq. ft. per hr, per deg. mean temperature difference, d, which is approximately equal to $t_s - (t_2 + t_1) \div 2$ where t_s is the temperature of exhaust steam, t_2 and t_1 as before. Substituting your figures:

$$d = 98 - (71.5 + 60) \div 2 = 32.25 \text{ deg.}$$

Equating the expression for the heat transmitted through the condenser tubes to that for the heat abstracted from the steam we get:

$$A\ U\ d = w\ (H - t + 32)$$

from which we obtain.

$$U = 365{,}000\ (1102.1 - 89 + 32) \div (50{,}000 \times 32.25) = 237.$$

This figure is rather low and probably accounts in a great measure for the large ratio of cooling water to steam condensed. For a new installation, perfectly clean, it should average about 1000; 600 or 700, we would say is a good working figure.

It is probable that the cause for this is dirty condenser tubes. With clean tubes your cooling water should not be far from 10,000,000 lb. per hr.

Examination Questions and Answers

WHAT DO you mean by the term a one-horsepower boiler?

2. Is there no more definite rating than this for the horsepower of boilers?

3. Does the horsepower of steam boilers, calculated according to this rule, come near the actual consumption in condensing engines?

4. In choosing a boiler, how would you determine the proper size, basing the horsepower on the consentaneous rating?

5. Is there any disadvantage in using a boiler larger than is strictly necessary to evaporate the required amount of water?

6. What boiler capacity would you use for the following kinds of engines, running, condensing, and non-condensing?

(A) High speed automatic cutoff, 100 hp.
(B) Plain slide valve throttling governor, 100 hp.
(C) Corliss type, 125 hp.
(D) Compound Corliss type, 200 hp.

7. What is the effect on the evaporative efficiency of a boiler in lowering the temperature of the feed water?

8. Can a boiler of a given size evaporate as many pounds of water per hour to a pressure of 100 lb. as to a pressure of 70 lb.?

9. Upon what does the grate-surface of stationary boilers depend?

10. How many pounds of coal can be consumed per square foot of grate surface per hour?

11. What do you mean by heating surface?

12. Give a rule by which you would calculate the heating surface of a return tubular boiler, also the horse power of boiler.

13. How much heating surface per hoursepower is provided in fire tube, and water tube boilers?

14. Can you thus calculate approximately the horsepower of any boiler?

15. What is the average ratio between the grate surface and heating surface of stationary boilers?

16. What is steam? (a) Give the total temperature of steam.

17. What is the cause of smoke? (a) How can it be prevented?

18. What is the result of scale in boilers, and why?

19. What injury would foaming produce?

20. What is a safety valve? (a) On what general principles is it constructed?

21. What determines the proper size of safety valve for different size boilers?

22. Does the steam gage register absolute pressure?

23. What is a water gage, and how is it actually analyzed?

24. What other devices are used for indicating water levels?

25. When a boiler is under steam, is the pressure on all sides of the boiler the same?

26. What factor is generally used in figuring the safe working pressure of boilers?

27. What value for tensile strength should be used in the rule for finding the safe working pressure of boilers.

ANSWERS

ONE BOILER horsepower is equivalent to the evaporation of 34½ lb. of water, from and at 212 deg., F., per hr.

2. Water tube boilers are usually rated at 10 sq. ft. of heating surface per boiler horsepower. This is an arbitrary makers' standard, however, and is not as accurate as the first rating.

3. There is no rational connection between the horsepower of a boiler and that of the engine which it supplies. Boiler horsepower, as stated in question 1, is the evaporation of 34½ lb. of water from and at 212 deg. F. per hr. which represents 970.4 B.t.u. per lb., or 33,479 B.t.u. per hr. On the other hand an engine horsepower is 2546 B.t.u. per hr., which is about 7.7 per cent of the boiler horsepower.

In choosing a boiler, its size should be determined by the steam consumption of the engine it is to supply. If your engine uses, for instance, 20 lb. of steam per hp.hr., your boiler will have to supply that much steam

and the rating would be $20 \times f \div 34\frac{1}{2}$ times the rating of the engine. Here f is the factor of evaporation.

5. If a boiler is larger than it actually need be for the service at hand, it will naturally not be working up to capacity and its efficiency will be lowered.

6. Boiler capacity necessary to supply an engine depends, as stated before, on its water rate.

(A) A high-speed, automatic cutoff 100 hp. engine will usually have a water rate, running condensing, of about $22\frac{1}{2}$ lb. per hp.hr. The boiler capacity necessary would be $22\frac{1}{2} \times f. \div 34\frac{1}{2} \times 100 = 65$ hp. if we consider f as unity. This same engine running non-condensing would have a water rate of, say, 29 lb. per hr. and the corresponding boiler horsepower would be $29 \div 34\frac{1}{2} \times 100 = 84$ horsepower.

(B) For a plain slide-valve, throttling governor, 100 hp. engine, the water rates, condensing and non-condensing, can be considered to be about $19\frac{1}{2}$ and 25 lb. respectively. The boiler horsepower necessary in this case would be $19\frac{1}{2} \div 34\frac{1}{2} \times 100 = 56\frac{1}{2}$ hp., or, non-condensing, $25 \div 34\frac{1}{2} \times 100 = 72\frac{1}{2}$ hp.

(C) A Corliss type, 125 hp. engine has a water rate condensing of about $16\frac{1}{2}$ lb. and non-condensing 21 lb. The corresponding boiler capacity would be $16\frac{1}{2} \div 34\frac{1}{2} \times 125 = 60$ hp. and $21 \div 34\frac{1}{2} \times 125 = 76$ hp.

(D) A compound Corliss engine of 200 hp. would have a water rate of, say, $14\frac{1}{2}$ lb. condensing and $18\frac{1}{4}$ lb. non-condensing. The boiler horsepower necessary would be, condensing, $14\frac{1}{4} \div 34\frac{1}{2} \times 200 = 84$ hp., and non-condensing, $18\frac{1}{4} \div 34\frac{1}{2} \times 200 = 106$ hp.

7. The effect of lowering the temperature of the feedwater to a boiler, is to lower the economic efficiency.

8. A boiler of given size with constant combustion conditions cannot evaporate as many pounds of water per hour to a pressure of 100 lb. as it can to a pressure of only 70 lb.

9. The area of the grate surface of a stationary boiler depends on the kind of coal used, the thickness of fire, the draft available, and the kind of stoking employed.

10. The pounds of coal that can be consumed per sq. ft. of grate surface per hr. varies in different installations from as low as $3\frac{1}{2}$ lb. to 41 lb., and even reaches the high mark of 225 lb. in locomotive practice. This, again, depends on the kind of coal used, the draft, and the kind of stoking.

11. The heating surface of a boiler is that part of the tubes and boiler shells which is exposed to the direct action of the combustion gases.

12. The heating surface of a horizontal return tubular boiler is composed of a tube surface and a shell surface. The extent of the tube surface is equal to the circumference of the tube in feet, times its length, times the number of tubes. The shell surface is equal to half the circumference of the shell in feet times its length. The tube sheet surface is usually not considered.

13. Water tube boilers are usually rated at 10 sq. ft. per hp., return tubular boilers, at 12 sq. ft.

14. By knowing the heating surface of any boiler you can thus approximate the horsepower capacity at rating.

15. There is no rational relation between the grate surface and the heating surface of a boiler, however, for a hand fired setting using bituminous coal, the ratio is usually about one to forty, grate surface to heating surface with natural draft. For anthracite coal, stoker fired or forced draft, this ratio would be decreased.

16. Steam is nothing more or less than evaporated water. The name steam is usually applied, however, to high temperature vapor. (A) The total heat of steam is usually expressed as: $xr + q$, that is "x" the quality of the steam times "r" the latent heat of evaporation plus "q" the heat of the liquid at the pressure under consideration.

17. Unconsumed carbon, resulting from an insufficient air supply is the usual cause of smoke. It can be prevented by using more air, by obtaining a better mixture of air and fuel or by providing a longer passage in which combustion can be completed before striking the heating surfaces of the boiler.

18. Scale formation in a boiler results directly in reduction in efficiency of heat absorption because of the insulating properties of this scale.

19. When a boiler foams badly, it carries excessive amounts of water over into the steam line. This water will accumulate in pockets in the piping and will, eventually, be blown into the engine unless traps are provided. If a slug gets into the engine, the chances are that the cylinder head will be blown off and the engine wrecked.

20. A safety valve is a valve that opens the boiler to atmospheric pressure when the pressure exceeds a certain given value. It is, essentially, simply a poppet valve, kept down on its seat by either a spring or a counter-balance.

21. The size of a safety valve depends on the pressure at which it is supposed to blow and also upon the weight of coal burned per square foot of grate surface per hour. It should be large enough to discharge all the steam generated by the boiler at maximum capacity with a rise in pressure of only 6 per cent. The A. S. M. E. code gives a table of safety valve sizes for various pressures and rates of firing.

22. A steam gage does not ordinarily register absolute pressure, but rather what is called gage pressure or pressure above that of the atmosphere which is normally 14.7 lb. per sq. in. lower than absolute pressure.

23. A water gage is simply a glass column connected to the boiler in a vertical position so that it shows the water level in the boiler. The top end is open to the steam space in the boiler and the lower end is in communication with water.

24. Try cocks are also used for indicating water level. There are usually three of them so located one above the other that the middle one indicates normal level, the upper one full boiler, and the lower one minimum level.

25. When a boiler is under pressure the pressure on all sides of the shell is the same, except for a slight increase toward the bottom, due to the head of water above.

26. The factor of safety generally used in figuring the safe working pressure of a boiler is five for new power and heating boilers, increasing with age to six for boilers that are 25 yr. old.

27. The tensile strength used in figuring the safe working pressure of a boiler varies with the material, usually between 55,000 and 65,000.

(To be Continued.)

Evaporation Test

WILL YOU kindly give me the answers to the following questions?

How much coal will be required to evaporate a given quantity of water?

What will steam cost per thousand pounds?

How many pounds of steam will a given boiler generate in 24 hr.? G. H. R.

ANSWERS

YOU HAVE given us no data as to the conditions under which your boiler operates, so that it will be necessary, in order to answer your questions, to make certain assumptions. If these assumptions do not meet with your conditions, it will simply be necessary to substitute your conditions for the ones given here and the answers thus obtained will apply to your case.

1. In order to be able to determine the amount of coal that will be required to evaporate for instance 1000 lb. of water, we must know (1), the heating value of the coal, B.t.u. per lb.; (2), the overall efficiency of the boiler and furnace; (3), the temperature of the feed water; and (4), the pressure under which the evaporation takes place.

We will assume first that you are evaporating water from a feed temperature of 212 deg. F. at atmospheric pressure, 14.7 lb. per sq. in., and that the steam being delivered is dry and saturated; i. e., there is no entrained water being carried along with the steam. Under these conditions, we find from a steam table, that 970.4 B.t.u. must be added to each pound of water or for 1000 lb., 970,400 B.t.u. will be required. Now if we are burning coal having a heating value of 13,000 B.t.u. per lb. with an overall efficiency of 60 per cent, then from each pound of coal we are able to utilize $0.60 \times 13{,}000 = 7800$ B.t.u. Then the amount of coal required to evaporate 1000 lb. of water will be $970{,}400 \div 7800 = 124.5$ lb.

If, however, we generate steam at 150 lb. abs. pressure from feed water at 100 deg. F. and if the steam is only, say 95 per cent dry, then our result will be different. For every pound of steam only 95 per cent of the latent heat will have to be added but the temperature of 100 per cent will have to be raised to the steam temperature. If X is the quality, r, the latent heat at 150 lb. pressure, q the heat of the liquid above 32 deg. F. and q_2 the heat in the feed water, then the total heat required will be

$$H = xr + q - q_2$$

The values for these quantities we can find in a steam table. Substituting them, we get

$$H = 0.95 \times 863.2 + 330.2 - 100 + 32 = 1082.24 \text{ B.t.u.}$$

From this we can get what is called the factor of evaporation, i. e., the ratio of the heat required to generate 1 lb. of steam under actual conditions to that required to generate steam from and at 212 deg. F.

$$F = 1082.24 \div 970.4 = 1.115.$$

The coal required then under these conditions would be

$$1115 \times 124.5 = 138.82 \text{ lb.}$$

If our coal costs $5 a ton delivered or ¼ cent per lb., then our steam will cost $138.32 \times \frac{1}{4} = 34.7$ cents per thousand. This, of course, includes only the actual cost of fuel. To this figure should be added the cost of labor, and the maintenance, interest, insurance and depreciation charges on the boiler room equipment.

3. One boiler horsepower is equivalent to the evaporation of 34.5 lb. of steam from and at 212 deg. per hr. If your boiler is rated at 100 hp. it will evaporate $34.5 \times 100 = 3450$ lb. of water per hr. from and at 212 deg. or $3450 \div 1115 = 3100$ lb. under actual conditions. In 24 hr. then it will generate $3100 \times 24 = 74{,}500$ lb. of steam.

Flow of Water from Well

I HAVE an artesian well 4 in. inside diameter; depth, 500 ft. With all fittings removed, the well showed a measured flow of 300 gal. per min. at ground level, with flow entirely stopped the well showed a gage pressure of 14 lb. or a head of 32.2 ft. What will the flow be at a point 24 ft. above ground level? R. O. C.

A. The flow from such a well would be calculated in the same manner as finding the flow from a reservoir. The flow from a reservoir through an opening on which the head, h, is 32.2 ft. is

$$Q_1 = CA\sqrt{2gh_1} = CA\sqrt{2g\,32.2}$$

where Q is the flow in gallons per minute, A is the area of opening, and C is a conversion coefficient from cubic feet per second to gallons per minute.

If now we have another similar opening, 24 ft. above the first one, the head will be $32.2 - 24 = 8.2$ ft. and the flow will be

$$Q_2 = CA\sqrt{2gh_2} = CA\sqrt{2g\,8.2}$$

The ratio of the flow in the second to that in the first will be

$$Q_2 \div Q_1 = CA\sqrt{2g\,8.2} \div CA\sqrt{2g\,32.2}$$
$$= \sqrt{8.2} \div \sqrt{32.2} = 0.503,$$

from which

$$Q = 0.503 \times 300 = 151.5 \text{ g.p.m.}$$

Bourdon Gage Construction

WILL YOU kindly describe a Bourdon gage and tell me why they are constructed sometimes with the major axis of the tube parallel with the spindle and sometimes perpendicular to it? L. C.

A. A Bourdon gage is composed essentially of a bent tube, having an elliptical cross section, which is fixed at one end and free to move at the other. The free end is coupled to an indicating needle to register pressure. When pressure is applied inside of this tube the section tends to change from an elliptical to a circular one. This action tends to straighten the tube and hence causes a movement of the free end which is transferred to the needle. All such tubes are constructed with the major axis, of the elliptical cross-section of the tube parallel with the indicating needle spindle. The action of the tube with this axis perpendicular to the spindle would be essentially the same, but there would be greater difficulty experienced in the process of manufacture and for this reason, probably, more than any other, the tubes have not been made in this manner.

EXPERIMENTS carried out in Germany during the war gave evidence of the beneficial effects of blast-furnace gas upon the growth and productivity of plants, due undoubtedly to the presence of carbon dioxide. By discharging the waste gas into one of three greenhouses the effect was visible by the increased growth of plants in that particular greenhouse in a few days. Plants exposed to the gas yielded from one to three times as much as those not treated.—Compressed Air.

POWER PLANT ENGINEERING

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Compulsory Metric Units

Spite of the tremendous expense and hindrance to business, especially the manufacture and operation of machinery, the Metric System advocates are still agitating for a law to compel everybody to use that system and to think in its units.

Congressman Fred A. Britten has introduced a bill in the House of Representatives and it is now before the Committee on Coinage, Weight and Measures, which if passed, will, after 10 yr. make every other system of weights and measures illegal in the United States, and will class anybody who uses any other system as a lawbreaker. Under one section, government departments are to use the system "not later than 10 yr." from the date of passage of the bill, hence could by executive ruling go at once to metric units for postal weights, excises, duties and customs weights and measures, as well as for specifications for purchases.

At present the Metric System is legal, but optional. Those who wish may use it for any purpose they choose. But Metric advocates are not satisfied and want to force its use upon the country, regardless of convenience. Industry has and will adopt the units most convenient for its purposes, and just why those who find metric units most convenient for their work should wish to make the use of other units more convenient for others, illegal is a problem only to be solved by studying the mental process of enthusiastic but impractical reformers. There is no such attitude on the part of those who like present units toward those who prefer to use metric units.

But the danger remains that the metric advocates may slip this or a similar bill through Congress unless senators and representatives are made aware that there is no need for such action, and that a considerable part of the people of the country are opposed to it. So unless you want our old and tried friends, the pound, ton, foot, mile, gallon, cubic foot, etc., made outlaws, association with which is a criminal offense, it will be well to let your representatives in Washington, especially members of the Committee on Coinage, Weights and Measures, know by personal letter and by resolution of organizations to which you belong, that this particular interference of government in business is not desired and is disapproved. If you let this bill pass by inaction, and in a few years have to buy and learn a new set of measures, and to think in millimeters, liters and grams, you will be getting fair return for lack of foresight. And you will be leaving the way open for all sorts of added unnecessary and harmful restrictive laws.

Air Leakage in Chimneys

Considerable attention has been given to the subject of air infiltration in boiler settings and the efforts that have been expended towards the prevention of such air leakage have no doubt been justified by the increased furnace efficiency obtained in most cases.

Common brick is a somewhat unsatisfactory material for boiler settings. It is a poor heat insulator; it is porous and permits considerable infiltration of air, and it cracks easily. It is not a refractory material and is, therefore, always protected from high temperatures by a lining of firebrick. While insulating material will

decrease the radiation losses quite effectively, on account of the joints in the brick the air leakage is not eliminated. Air leakage is dependent upon the tightness of the joints rather than upon the material used.

A number of methods are in use to decrease or eliminate the air leakage losses in boiler settings, each of which are more or less effective. Savings effected by certain of these methods are said to be sufficient to repay the first cost in less than six months.

It is obvious, therefore, that unless properly guarded against, the amount of air leakage through boiler settings is considerable. If this is true of boiler settings, why is it not also true in the case of brick chimneys? Chimneys are subjected to stresses caused by the varying forces of wind and temperature which without doubt cause the resistance of the joints to air flow to become reduced. This causes a reduction in the available draft and the effectiveness of the chimney is impaired.

Due to the rather meager data available on this subject, the article in this issue by Alfred Cotton will be of interest. Mr. Cotton has investigated the effect of air infiltration on heat losses in chimneys and has reached conclusions of considerable importance. While experiments or tests in this particular field are somewhat difficult to make, the argument used by the writer is sufficiently logical to point out the desirability of such tests being made. Just as soon as the actual conditions are known as regards air leakage in chimneys, steps can be taken towards its prevention as has been the case with boiler settings.

The possible saving that may be obtained by rendering a chimney airtight, as pointed out by Mr. Cotton, seem to indicate that efforts spent in this direction will be fully justified from an economic viewpoint.

Off Duty

Off duty! Well, that's good news. It's been pretty hot these days and a short vacation won't harm any of us. Pretty hard to keep one's mind on his work when the thermometer begins to hover around the one hundred mark. Our thoughts are more likely to turn towards fishing and we begin to dream of cool shady nooks near lakes far removed from the everlasting noise and smoke and turmoil of cities.

So we say good-bye to the gang at the plant, dig up the old fishing tackle, spend half of last year's salary for a railroad ticket and we are on our way. In a day or so we find ourselves dozing away in solid contentment in that cool shady nook we dreamed about. Nothing worries us, not even the thoughts of what it will cost to get back. The fish are not biting much today, but what do we care—too much work to take 'em off the hook, anyway.

All is quiet. Only the gentle rustling of the leaves and the occasional cry of a bird or the splash of a frog as he dives from a moss covered rock break the stillness of the summer afternoon. Three o'clock! The gang at the plant are just about starting up number three to handle the afternoon peak. Bet it's hot down there—feel sorry for the boys. O, well, why worry about them? Life's too short.

Nearby a cornfield waves its golden tassels in the sunshine. It must be hot out there—probably a hundred degrees. Wonder the plants don't wilt and die of the heat; but no—of course not, they don't die—that's why they live, because of the sunshine. That's why we live; why everything lives.

All life and everything that life accomplishes depends upon the sun—upon the solar energy stored up in the form of food and fuel.

The corn plant waving its golden tassels in the sunshine is just as much a power plant as the one with its grimy smokestacks in which we earn our living. It is true the corn plant doesn't make, that is, create energy but, as a matter of fact, neither does our power plant. It merely transforms the potential energy of the coal into a form for our use. The corn plant or any other form of vegetation transforms the heat energy of the sun into the potential energy of food and fuel, and in doing this it is far more efficient than man in carrying out its transformation.

The chief sources of energy in food are the fats and the sugars. The fats contain two-and-a-quarter times the potential energy of the sugars, but both when completely purified consist of nothing but carbon, hydrogen, and oxygen; elements that are found in abundance everywhere in air and water.

These elements, it will be seen, are also contained in coal and that reminds us that coal itself is nothing but the product of prehistoric forests and sunshine; "solidified sunshine," Slosson calls it. It is nothing more than the concentrated solar energy of bygone ages that is liberated when we burn coal in the furnaces under our boilers, a very wasteful procedure in which 85 to 90 per cent of the energy is normally wasted.

The corn plant works silently and efficiently. Man, too, has learned to do what plants do, but in most cases he is very inefficient. He takes a thousand horsepower, and by making a great deal of heat and noise is able to combine carbon with hydrogen, while a little leaf in the sunshine does it quietly without becoming hot about it. We have accomplished a great deal, but we still have much to learn from nature.

We have referred to the fact that the carbon, hydrogen and the oxygen in the sugars and fats which we get from plants are likewise to be found in coal. And like coal, so can corn be used for fuel—not only as fuel for the body, but also as fuel for the furnace. The final products, water and carbon dioxide, are in both cases the same and therefore the amount of energy produced is the same in the body and in the engine.

But, confound it, anyway!—now we've spoiled the whole thing. We started out to take a vacation and here we're getting back into thermodynamics; it's no use, an engineer can't get away from it.

Power Plant Slogans

Keep and Analyze Operating Records in Every Power Plant.
Develop Water Power Sites.
Promote Health and Safety in Power Plants.
Handle Coal and Ashes Mechanically.
Employ Engineers for Engineering Work.

New Diamond Valve-in-Head Soot Blower

By Robert June

THIS introduces a new principle in soot blower design, the valve, controlling the individual unit, being incorporated as an integral part of the head. A large measure of the success of the mechanical soot blower has been due to constant improvements in design and construction, such as the protection of the blower elements from oxidation at high temperatures; adaptation of nozzles to secure the highest possible velocity of the steam jets; the development of special processes for welding these nozzles in place; design of steel bearings to support the blower elements; introduction of the vertical header system of piping.

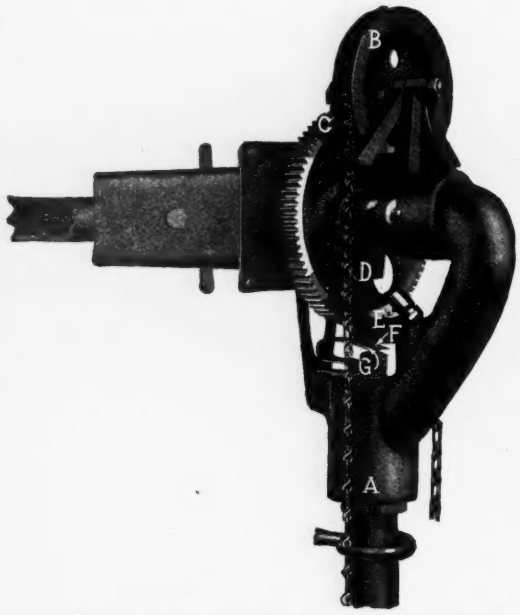


FIG. 1. ASSEMBLED VALV-IN-HEAD BLOWER UNIT

Successes have proved a spur to further efforts, hence, the new Valv-In-Head soot blower, manufactured by the Diamond Power Specialty Co.

This blower is provided with a special valve of the poppet type, placed at the base of the gooseneck, which takes the place of the globe valve that has always been installed at a distance from the head in the riser pipe leading from the main header. The object is to eliminate entrance of condensate into the portion of the blower inside the boiler.

The special valve just referred to is located at the point marked A in Fig. 1.

The unit is operated in the following manner: The main control and drain valves, which are the only independent valves on the soot blower line, having first been opened, and all piping drained and heated, dry steam fills the line to the entrance of the individual valve at the base of the gooseneck. The sheave wheel B is then revolved by pulling the chain. This turns a small cut pinion gear, see Fig. 2, which engages the large gear C mounted on the blower element. As the gear is revolved, it operates cam D, which causes lever E to press down valve stem F, opening the valve at a pre-determined point in the revolution. After the gear has been further rotated, the cam D releases the lever E, allowing the steam pressure to close the valve at a second predetermined point in the revolution. As steam leaves the line, the spring G holds the valve closed.

The valve is made with Monel metal disc and seat, stem and retaining nut being of nickel steel, with the end of the stem heat treated to secure extra hardness. A special feature is the provision of a guide on the seat which permits leaving the stem loose in the disc so that the valve will always seat properly. Disc and seat are readily accessible so that they may be removed easily for re-grinding or renewal.

As the tendency toward high pressure and superheat is marked in modern power plant design, a special steel body blower is made for such boilers as require this type of equipment.

Movement of the cam is positive, assuring complete automatic opening of the valve at each operation, the length and relative position of the cam being individually determined for each unit at the time of the installation. The valve lever has a ratio of two to one, and the reduction of the gears is ten to one, giving the chain an effective power arm of 100 to 1 and a resistance arm of 5 in.

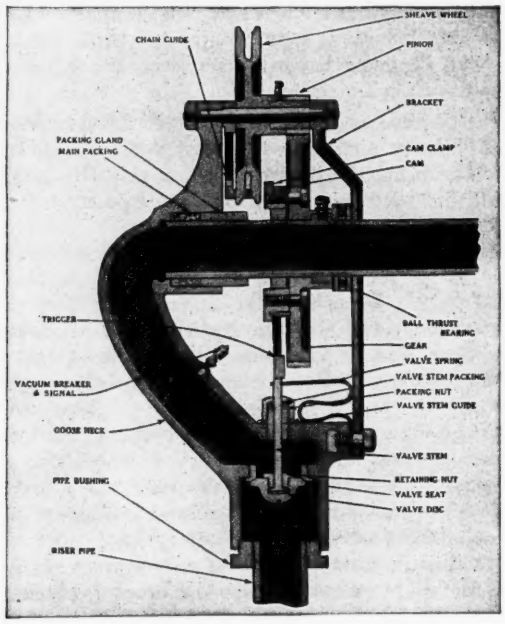


FIG. 2. CROSS-SECTION OF VALV-IN-HEAD SOOT BLOWER

Each head is provided with a vacuum breaker to prevent suction of furnace gases into the blower element during the periods when steam is off. In the present head, the vacuum breaker has been designed in the form of a small brass whistle. During the time that the soot blower is in operation, the whistle sounds, furnishing an audible and visible signal, so that no operator can leave steam on the unit when not revolving the blower without the fact becoming readily apparent to anyone in the vicinity.

Provision of guides to prevent the chain from slipping off the sheave wheel enables the operator to work the blower from any convenient point.

A ball bearing is provided to relieve the friction caused by the thrust due to steam. As will be seen from the cross section of the head, Fig. 2, this ball-thrust bearing is located directly back of the steel wall bracket which supports the blower element and permits the unit to turn as readily with the steam on as off. An important development is the wall box, with floating mechanism, which provides a means of taking care of any shifting of position of the blower element.

One of the most important results of the use of this blower is the practical elimination of water entering the soot blower. Condensation will inevitably take place when steam is admitted to the cold line, and a more serious possibility is that a small leak in the valve will cause water to collect in the pipe. When this occurs, a solid column of water may be built up in the riser pipe and carried over into the blower, if the valve is at a distance from the blower head.

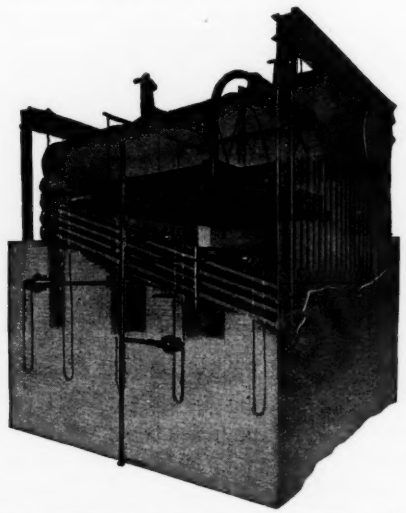


FIG. 3. SOOT BLOWER APPLIED TO HORIZONTAL WATER-TUBE BOILER

The presence of this condensate in the hot blower element is apt to cause warping, and its discharge on the boiler tubes may cause the soot to pack, forming a gummy mixture hard to remove.

With the new system, condensate in the main supply line is discharged through the drain pipes before blowing begins, and as the radiation area in the head itself is so small as to be negligible, there is practically complete elimination of condensate from the blower element.

With this system a single round trip completes the cycle of operation, which effects a marked saving in labor. Furthermore saving in steam is effected, as a result of the cutting down of waste from blowing while the operator attends to the independent valves.

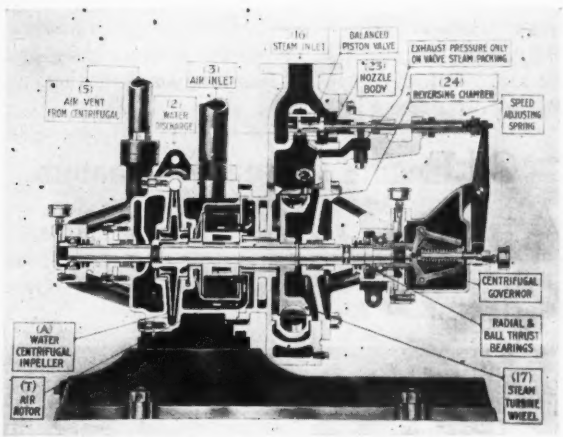
Increase in effective pressure in the blower element is due to two factors; the valve offers practically a straight passage to the steam; and the system requires a minimum of pipe and fittings so that the pressure drop from source of steam to blower element is small. With increased pressure and velocity, the range of the steam jets is considerably greater, and the boiler is thoroughly cleaned.

Jets blow only when the nozzles are directed at parts of the boiler from which deposits of soot must be removed, steam being automatically cut off from the blower element at the precise point in its revolution at which the jets would begin to strike the baffles or other parts which might possibly be affected by contact with the live steam. The cam may be so constructed as to permit blowing of the unit at two or more arcs in the revolution, so that steam may be cut off when the jets approach a baffle and turned on again when the baffle is passed. With oil-fired boilers, this ability to control the arc of the steam jets is particularly valuable as it makes possible the avoidance of interference with draft to the detriment of combustion.

Boilers are only effectively cleaned when the steam jets play on the tubes for a predetermined period of time, and the gear reduction arrangement provides for the revolution of the soot blower element at a speed regulated to conform to the proper length of time for blowing.

Turbine Driven Air and Condensate Pump

THE NASH Engineering Co. has recently developed a novel type of steam turbine driven return line heating pump. The cross sectional drawing shows the general design of this unit, which consists of an air pump that exhausts the air from the system, a centrifugal pump to remove the hot condensate and return it to a feed-water heater or hot well, and a steam turbine to drive the unit; all mounted on one shaft and assembled in the same casing.



CROSS SECTION OF PUMP SHOWING AIR AND CONDENSATE PUMP AND TURBINE MOUNTED IN A SINGLE CASING

The Jennings turbine driven unit is especially designed for use in connection with heating or drying systems where the pump is called upon both to maintain a vacuum on the heating system and to return the hot water and condensation against a pressure.

The unit consists of two independent turbine pumps built in one casing; one pump handling the air, the other the condensation, the air and condensation being separated in a receiver under vacuum before entering the unit. This arrangement makes possible the large saving in power, because the condensation, which is only one-eighth of the volume handled, is alone delivered against discharge pressure, the air being delivered free to the atmosphere. Furthermore, the air is handled in

a pump designed for air, while the water is handled in a pump designed for water. This permits a much higher efficiency than would be possible in one pump handling both air and water.

The air end of the new turbine driven unit is a development of the Hytor vacuum pump in which the rotor, the only moving part, revolves in an elliptical casing filled with water. The water turns with the rotor, but follows the casing, due to centrifugal force.

The water end of the machine is a centrifugal pump with an enclosed type impeller designed to give high efficiency when handling hot water. It has the very desirable characteristic of unloading when not handling condensation, and at the same time will require very little increased power when delivering against low heads. Provision has been made by special construction to vent the centrifugal inlet back to the receiving tank, which is under vacuum, so that air binding is impossible.

All interior parts of the pump are constructed of bronze with the exception of the steam turbine rotor. No lubricant is required in the interior of the pump. No oil or grease can be introduced by the pump into the condensate. As the condensate is usually returned to a hot well, tank or feed-water heater for boiler feed purposes, this feature is desirable.

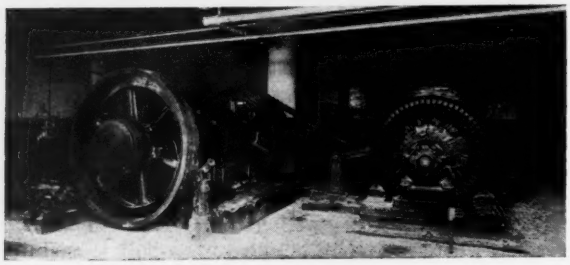
The shaft upon which the impeller, rotor and steam turbine wheel are mounted, is supported by annular ball bearings mounted outside of the casing, in an adjustable housing.

The steam turbine rotating element consists of a solid steel forging with blades milled out of the rim.

A centrifugal throttling governor is used to maintain a constant turbine speed. This governor automatically shuts off steam if the steam pressure rises or if the pump unloads when not handling condensation, preventing all increase in speed.

Oil Engine Driven Alternators

AN INTERESTING example of a very modern type of power house practice—the use of oil engines to drive alternating-current generators—is found in the new plant of the General Silk Importing Co. at Passaic, N. J.



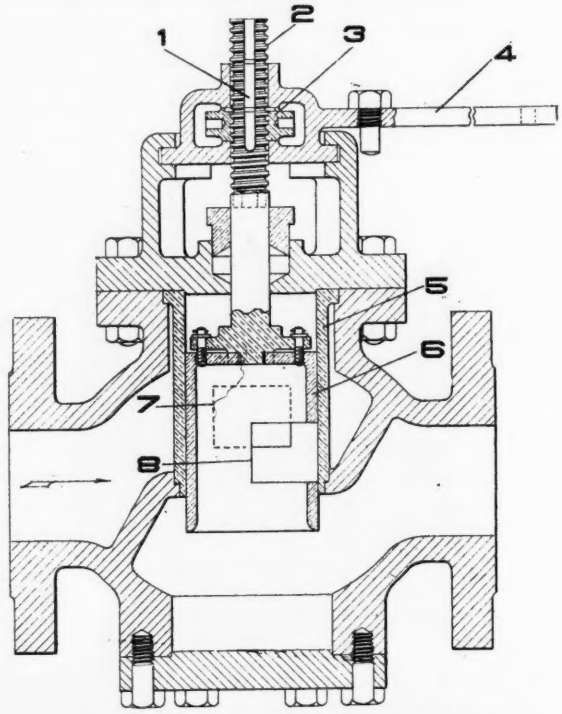
OIL ENGINE DRIVEN ALTERNATORS AT GENERAL SILK IMPORTING CO.

The service conditions in this plant require a fairly large amount of power, but a very small amount of steam, merely enough to heat the moderate sized structure, and that, of course, only in cold weather. Hence it was decided not to install a steam power plant, but to rely entirely on the more economical oil engine.

The equipment selected consists of two 250-kv.a., 480-v., 3-phase, 60-cycle Westinghouse alternators, operating at 600 r.p.m., and with direct-connect 5-kw. exciters. Each alternator is belted to a 260-hp. Fairbanks-Buckeye oil engine of a much lower speed. These engines are of the Semi-Diesel type and run on light fuel oil.

Adjustable Chronometer Valve

THE object of the adjustable chronometer valve is to provide means for adjustment whereby the effective area through the ports can be limited without limiting the stroke of the regulator.



SECTION OF ADJUSTABLE CHRONOMETER VALVE

Fan engine, stoker engine or damper regulators of the hydraulically operated type cannot well be brought into step with a valve in which the maximum port openings are excessively large for the requirements, as a unit movement of the regulator will effect too great a change in wind box pressure and stoker speed, which not only has a bad effect upon the furnace, in that holes may be blown in the fuel bed, but may develop into a continuous hunting action which would result in a wide range of furnace temperature beyond that due to the swing of the load and a decreased boiler efficiency.

A solution of the problem of determining in advance the correct size of valve for every load condition is to use a valve which can be adjusted to effect gradual changes in fan engine and stoker speed, and in this way the maximum port openings of the valve will correspond with the maximum speed of the fan and stoker engine for any possible peak load.

Referring to the accompanying drawing: Steam flows through the valve in the direction indicated by the arrow. The valve cage (5) has a number of ports (7), a valve (6) is mounted to slide and rotate in the valve cage and has ports (8) arranged to register more or less with the ports in the valve cage. A valve stem

(2) is rigidly connected with the valve (6) and is keyed to an actuating lever (4) which permits the valve to be rotated by the regulator in opening and closing, the ports registering between the valve and valve cage.

The bonnet of the valve has a projection having guideways formed on a radius with the valve spindle and arranged to receive an extension of the yoke of the actuating lever. An adjustable nut (3) is mounted on a thread on the valve stem and is secured against lateral motion by being held in the yoked end of the lever. The screw nut (3) may be adjusted to give a lateral motion to the valve stem to close off more or less of the port openings registering between the valve and valve cage, and the actuating lever may be moved through a given arc by the regulator to open and close the ports in another direction when so adjusted and held in accordance with the pressure acting on the regulator.

These valves, manufactured by the Ruggles-Klingemann Mfg. Co., are made for reducing pressure, for maintaining in constant back pressure for controlling turbine driven pumps and for any purpose where a damper regulator is used to control a valve, besides for use in connection with the fan engine or stoker engine mentioned.

Book Reviews

STEAM BOILER ENGINEERING; 27th edition of Helios; compiled by the Research Department of the Heine Safety Boiler Co., 639 pages; illustrated; 6 by 9, cloth; St. Louis, 1920.

This edition is practically a new book; it has been entirely rewritten and greatly extended in scope. The subject matter covers, in a practical manner, the theory of steam generation, design of boilers, furnaces, chimneys, piping and auxiliary layouts; and instructions for testing and operating boilers in accordance with the most approved methods are given. Subjects that also come in for discussion are superheaters, mechanical stokers, mechanical draft, insulation, feed, and feed water.

The volume is well illustrated and much of the information is condensed in the form of tables, charts and graphs.

PROCEEDINGS OF THE PHILADELPHIA AND NATIONAL CONFERENCE OF THE CONSTRUCTION INDUSTRIES; 254 pages, 8 by 10½, illustrated, paper, Philadelphia, 1921.

This volume sets forth the proceedings of the two conferences held, one in Philadelphia in February and one in Chicago in March, under the auspices of the Industrial Relations Committee of the Chamber of Commerce of Philadelphia and the National Federation of Construction Industries. It concerns itself with the present condition of the construction industries and how these conditions may be improved.

Employers, employes, bankers, dealers, manufacturers, engineers, architects, contractors, public officials, real estate dealers, transportation and fuel interests and others who are either directly or indirectly interested in the construction industries were represented at both of these conferences.

Particular attention is called to the analysis of construction costs, Chap. IV; to the employer's point of view on wages, and production, Chap. VII; to the views of union labor, Chap. VIII; and to the resolutions passed, Chapters X and XIV.

THIRD POWER KINK BOOK, McGraw Hill Book Co.; 264 pages, 6 by 9, illustrated, New York, 1921.

This work is a collection of short articles describing kinks which have proved useful in making emergency power plant repairs. Each kink is accompanied by a chart or illustration and is described in the words of the originator. The collection treats of kinks in the boiler and engine room, pumps, valves, lubrication, pipes, electricity, internal combustion engines, condensers, gages, compressors and in heating systems. A handy book for the repair man.

News Notes

THE 14TH annual convention of the Pennsylvania Electric Association will be held at Bedford Springs, Pa., Sept. 7 to 10 inclusive. There will be morning and afternoon sessions except on Saturday, when the final session will be held in the morning. The program opens on Wednesday evening, Sept. 7, with the reception to the president. On Thursday morning the chief features will be the address of the president, Henry Harris of Wilmerding, the appointment of auditing and nominating committees and a paper on "The Super Power Survey as it May Affect Pennsylvania," by Harold Goodwin, Jr. The afternoon session will be a commercial meeting with a number of interesting reports and papers. The technical session will be held on Friday morning, Sept. 9, while the accounting session wll be held on the morning of Saturday, Sept. 10.

The officers of the association are: President, Henry Harris, Wilmerding; first vice-president, A. H. S. Catlin, Allentown; second vice-president, Ernest H. Davis, Williamsport; treasurer, H. H. Ganser, Norristown; secretary, Henry M. Stine, Harrisburg.

THE WESTINGHOUSE Electric & Mfg. Co. announces a 10 per cent reduction on prices of practically all industrial motors and motor control apparatus, including also all direct current generators and motor generators. This is the second cut of 10 per cent made by this company in motor prices during this year. There is also a reduction in prices on heating appliances, such as toaster stoves, irons, chafing dishes, cozy glow radiators, etc., the new prices to take effect immediately.

DAYTON-DOWD Co., of Quincy, Ill., has opened a new district office in the Pioneer Building, St. Paul, Minn., in charge of George M. Kenyon Co.

THE C. & G. COOPER Co. has opened an office, suite 626, Great Southern Life Building, in Dallas. H. P. Simpkinson, who has been transferred from the home office, is in charge of the new branch.

THE EVERLASTING VALVE Co. announces that its general office, including the sales department, formerly established in New York City, has been moved to its new office at the factory at 49 Fisk St., Jersey City, N. J.

A. F. ZACHER has resigned, effective at once, as district manager of the Buffalo office of Economy Fuse and Mfg. Co., whose home office and factory is located in Chicago.

THE BABCOCK & WILCOX CO. announces the death of James Prentice Sneddon, its general superintendent, on Saturday, June 11, 1921.

F. T. WHITING, manager of the engineering division of the Chicago office of the Westinghouse Electric & Manufacturing Co., has been appointed manager of the industrial division of that office, to succeed N. G. Symonds, who has just been made manager of the Chicago office.

P. H. Smith has been appointed manager of the power division of the Atlanta office.

EXAMINATION will be held by the U. S. Civil Service Commission for position as assistant curator Division of Mechanical Technology. Entrance salary $1500 to $1800 a year depending on the qualifications of the appointee. Duties are designing and overseeing the development of educational exhibits, answering correspondence and research work leading to publication of educational bulletins on technical subjects.

All graduates of recognized colleges of engineering and graduates from normal schools with 4 yr. experience in teaching technical subjects are eligible. Applicants should submit record of education and experience, and reports, publications or theses of which they are sole or joint author upon topics related to the field of engineering. Apply to the Civil Service Commission, Washington, D. C., for Form 2118, stating the title of the position as given at the first of this notice. Applications must be properly executed and filed with the required material with the Commission at Washington by Aug. 9, 1921.

Trade News

CHAS. CORY & SON, INC., 183-187 Varick St., New York City, has secured the manufacturing and selling rights for the Royer line of portable and stationary flow indicators. These were formerly manufactured and sold by the A. H. Sloan Co., of Detroit, Mich.

JUDGE HAZEL, of the Federal Court at Buffalo, N. Y., has rendered decision sustaining the broad patent of The Permutit Co. on Zeolite Water Softeners and ordering an injunction against infringing defendants. A pamphlet giving full particulars of the litigation may be obtained by firms who wish them from The Permutit Co., 440 4th Ave., N. Y. City.

QUALITY OF STEAM by the Throttling Calorimeter is the title of a booklet just published by Tracy Engineering Co., of San Francisco, describing in detail the method of constructing and installing and of using throttling calorimeters, presenting the technical reading matter of value to engineers in the line of explaining instruments and methods for determining moisture in steam.

THE INGERSOLL-RAND CO., 11 Broadway, New York, has just issued a 24-page booklet which illustrates and describes its complete line of "Little David" pneumatic tool accessories. The booklet covers all the various accessories which are used in connection with air tool service. It includes air hose, hose couplings, hose clamp and menders, air drill chucks, rivet sets and blanks, rivet set clips, chisels and chisel blanks, oils and greases, wire brushes, grinding wheels and rail drilling equipment. Convenient tables of dimensions of all rivet sets and chisels are given.

M. T. DAVIDSON CO. has just issued a new catalog, "Davidson Steam Pumps," which describes in a general way the company's boiler feed, high pressure hydraulic, mine service, ammonia, vacuum, deep well plunger, elevator, and mill pumps.

A FOLDER entitled The Important End of the Radiator illustrates different types of The Ohio Brass Co.'s radiator valves.

BULLETIN No. 210, of Freeman-Riff Co., Terre Haute, Ind., describing the company's F-R portable conveyors, has just been received.

AUXILIARY apparatus for storing, transporting and conditioning liquid fuels is the subject of a new illustrated bulletin, L F 104, from The George J. Hagan Co., Pittsburgh, Pa.

ROCHESTER automatic lubricators are illustrated and described in a catalog lately issued by Greene, Tweed & Co., of New York.

ALTERNATING CURRENT generators, engine type, are discussed in Bulletin No. 1115, superseding Bulletin No. 1098, from Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

GENERAL ELECTRIC CO., in Bulletin No. 47,030A, superseding Bulletin No. 47,030, entitled "Switchboards for Merchant Ships," gives a general idea of what has already been accomplished in the successful application of electricity to shipboard service.

The sectional type of panel switchboard has been developed and standardized for the control of marine engine generators rated up to 25 kw., 125 v. and for distribution circuits for lighting and auxiliary service on merchant ships. It is designed for use with one or more direct-connected marine engine sets. This is a marked advantage, as it permits flexibility in providing for feeder circuit requirements, which vary to a certain extent in different ships. Furthermore, a complete switchboard can be made up of as many generators and feeder panels as desired to control as many generators and feeder circuits in parallel as the installation may require.

The bulletin, in describing the construction of marine switchboards, brings out the following distinctive features: Metal parts have non-corrodible finish, all panels are mounted on strong angle-iron frames, each circuit is provided with a beveled copper name-plate, generator sections can be equipped with enclosed fuses or air circuit breakers for overload protection, and feeder sections make possible the control of a variable number of feeders.

Specifications for the equipment of sections with fuses, accompanied by diagrams, as well as a large number of illustrations, are contained in this interesting bulletin.